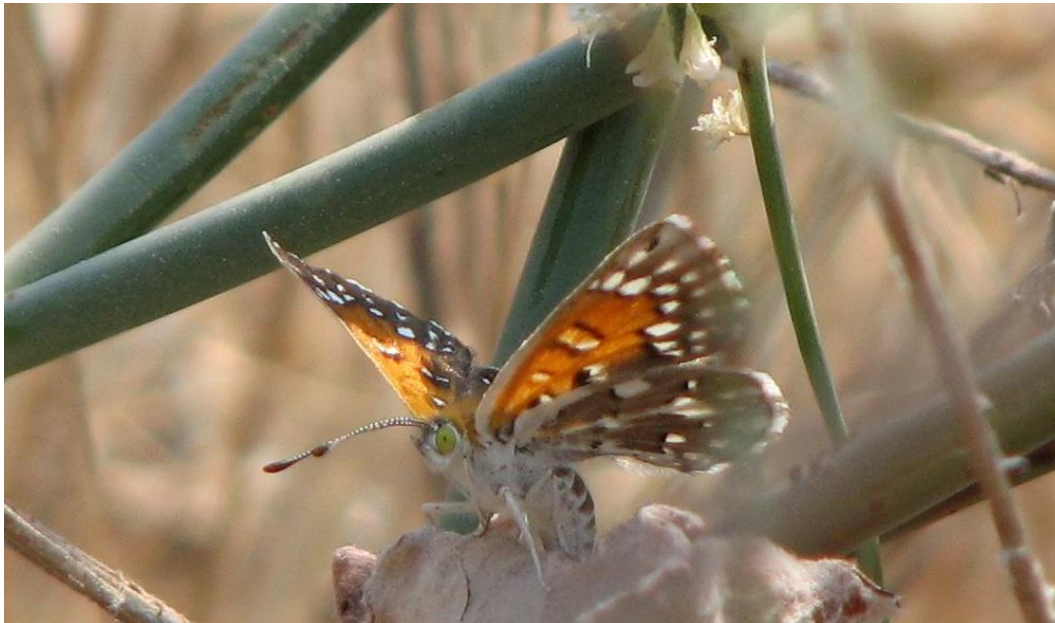




Central Valley Project Improvement Act Habitat Restoration Program

FY 2009 to 2010 Final Report - R09PG20050

Habitat Restoration for Three Endangered Species at the Antioch Dunes National Wildlife Refuge and Captive Propagation of the Endangered Lange's Metalmark Butterfly



The endangered Lange's metalmark butterfly perched on a Naked-stemmed buckwheat plant

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Table of Contents

Introduction:	3
Habitat Restoration:.....	5
California Conservation Corp	6
Allied Waste Disposal Dumpsters	8
Sand Dune Restoration:	9
Grazing Project:.....	10
Host plant Production:	12
Volunteers & Outreach Work	14
Lange’s Metalmark Butterfly Propagation:.....	15
Project Results:	19
Discussion:	26
Literature Cited:	28
Appendix:	30

Tables and Figures

Table 1: FWS Funds	20
Table 2: Budget Re-allocation for the CVPIAHRP Grant for Antioch Dunes NWR.....	20
Table 3: Allied Waste Disposal Dumpster Loads in 2009 & 2010	21
Table 4: Volunteer Work Hours	22
Table 5: Habitat Restoration & LMB Propagation Progress.....	22
Table 6: LMB Propagation Progress	23
Table 7: LMB Larvae Released on Stamm Unit by Dr. Jana Johnson & The Urban Wildlands Group June 2010.....	24
Figure 1: Annual Peak Counts for Lange’s Metalmark Butterfly at Antioch Dunes NWR.....	25
Figure 2: Antioch Dunes evening primrose counts between 1985 and 2010.....	25
Figure 3: Contrast Costa wallflower counts between 1990 and 2010.....	25

Introduction

The Antioch Dunes National Wildlife Refuge was established in 1980 in order to protect and conserve three endangered species that includes the Contra Costa Wallflower (*Erysimum capitatum angustatum*), the Antioch Dunes evening primrose (*Oenothera deltoides howellii*), and the Lange's metalmark butterfly (*Apodemia mormo langei*). The populations of these three federally endangered species are for the most part endemic to the Antioch Dunes National Wildlife Refuge. All three species are threatened by the loss of their habitat which was reduced from an estimated 494 acres to about 55 acres (Powell 1983; U.S. Fish and Wildlife Service 2002). In addition to the elimination of its habitat, exotic plants are diminishing the two endangered plants as well as the host plant for the Lange's metalmark butterfly (naked stemmed buckwheat or *Eriogonum nudum psychicola*). The number of Lange's metalmark butterflies (LMB) has plummeted from an estimated 25,000 individuals between 50 to 100 years ago, to over 2,342 individuals in 1999, and to just under 100 individuals in 2010 (U.S. Fish and Wildlife Service 2010). The refuge and the endangered species that call this refuge home have greatly benefitted from the funds granted by the Central Valley Project Improvement Act Habitat Restoration Program (CVPIA HRP) from 2007 to 2010. The CVPIA HRP has been responsible for funding a large portion of the habitat restoration and essential invasive plant management at the refuge over the last four years. The CVPIA HRP has also been the sole source for starting and funding the critical Lange's metalmark butterfly propagation project in this time span.

The habitat restoration and invasive plant management projects on the refuge have been crucial for the survival of the Lange's metalmark butterfly and the two other endangered species. The refuge is severally threatened by invasive plant infestation. The main concern of the refuge is to control invasive plants that directly threaten the wallflower and primrose through competition and strangulation. The Lange's metalmark butterfly (LMB) is indirectly threatened by invasive plants. The host plant for the LMB, the naked-stemmed buckwheat is directly threatened by invasive plants. Since the lifecycle of the LMB revolves around the host plant, then the loss or deterioration of the host plant may result in the loss of the LMB eggs or

larvae and the decrease of the LMB population. The most threatening invasive plant species on the refuge is winter vetch or *Vicia villosa*. Winter vetch is a legume that acts as a vine and climbs and smothers other plants. It is an extremely invasive plant in sandy habitats like the Antioch Dunes NWR and has been spreading rapidly throughout the refuge for the last ten years. The invasive plant infestation on the refuge is particularly vexing where invasive plants are mixed in with the endangered plants and the host plant for the Lange's metalmark butterfly. Where endangered plants and vetch are mixed the Invasive plant management becomes tedious, expensive and logistically problematic. Under these circumstances the endangered plants and host plants need to be identified, flagged and the vetch needs to be carefully removed by hand from the plants. Secondarily the excess invasive plants and standing vegetation matter is also potential fuel for large wildfires during the dry summer time. In the past we have had large wildfires burn off relatively large portions of the refuge. For example, an 11 acre fire in 2006, and a 24 acre fire in 2002 burned on the Stamm Unit. That represents a fire over 20% of the refuge in 2006 and 44% in 2002 on the entire 55 acre refuge. A good percentage of the plants will return after a fire, but the LMB are lost in wildfires. Thus, fire management is also a primary concern of the refuge.

Some of the habitat restoration and invasive plant management projects funded by the CVPIA HRP over the last four years includes sand dune restoration in 2008, cattle grazing from 2008-2010, manual labor by the California Conservation Corp in 2009 & 2010, invasive plant material disposal from 2009 to 2010, and North Coast Native Nursery naked-stemmed buckwheat propagation from 2007 to 2010. The Lange's metalmark butterfly propagation project has been entirely funded by the CVPIA HRP from 2007 to 2010. The Lange's metalmark butterfly propagation program has acted as an insurance policy or safety net for the LMB for the last four years and is a crucial program for the survival of the LMB. The past large wildfires on the refuge have played a large role in the decline of the Lange's metalmark butterfly population. If there is a single catastrophic fire or event on the 55 acre refuge, the captive LMB could be used to repopulate the refuge.

The following report will cover the work completed and results during the fiscal year of 2009 through 2010. This includes work and decisions made during habitat restoration, sand dune restoration, the grazing program, and host plant propagation program. The report will also cover the LMB propagation program contracted out to the Urban Wildlands Group.



The endangered Antioch Dunes evening primrose (left) and the endangered Contra Costa wallflower (right)

Habitat Restoration

The Antioch Dunes National Wildlife Refuge was established in 1980; it is the only Refuge specifically established for protecting endangered plants and insects. It is the remnant of a formerly large riverine sand dune ecosystem that is an isolated island of natural habitat surrounded by industrial development, homes and the San Joaquin River. At the end of the last Ice Age, summer winds sweeping the floodplains along the western foothills of the northern Sierra Nevada picked up the sand and deposited it in dunes, generating the dune field of eastern Contra Costa County. The vast majority of these dune habitats have been developed for agriculture or urban development, or mined for use as construction materials. Due to dredging and the creation of levees along the San Joaquin River, the riverine dune system no longer functions as a natural active dune system. The remaining portion of the Antioch Dunes has been highly altered, fractured, isolated and inundated with non-native invasive plants. For this reason the refuge must be highly managed annually, in order to mimic the natural sand movement and remove the invasive plants that threaten to cover the entire refuge. Habitat restoration and the Lange's metalmark butterfly propagation are two collaborative programs funded by the CVPIA HRP in 2009 and 2010, and the success of the LMB

population at the Antioch Dunes National Wildlife Refuge depends on the success of both of these two crucial programs. Habitat restoration at the Antioch Dunes National Wildlife Refuge includes manual labor, the use of heavy equipment, herbicide spraying, sand dune restoration, cattle grazing, host plant and endangered plant propagation, planting and seeding.

Due to the intermixing of the endangered plants, native plants and the host plant for the endangered butterfly with multiple species of non-native invasive plants, a large portion of the work must be completed by manual labor. This includes controlling invasive plants by hand pulling, and using hand tools like hoes and weed wrenches. Methods also include controlling invasive plants with power tools like weed whackers and small mowers. The refuge staff for the Antioch Dunes, Marin Islands and San Pablo Bay National Wildlife Refuges only includes 4.5 full time staff members. Since our resources are limited, we must implore the help of volunteers, court ordered community service workers and interns. However, the bulk of the work is completed by contracted workers like the California Conservation Corp.

California Conservation Corp Work



California Conservation Corp members install a barbed wire fence for the grazing project at Antioch Dunes NWR.

The CVPIA HRP for 2009 & 2010 funded valuable habitat restoration, invasive plant control and fire management work completed on the Antioch Dunes NWR by the California Conservation Corp (CCC). \$30,000 out of the total \$125,656 granted from the CVPIA HRP (24% of the total funds) were allocated to contracted work from the Northern Division Napa Center CCC office. The CCC's are a State Agency that promotes the work development and experience of 18 to 23 year old men and women. The agency specializes in natural resource work that includes invasive plant control and fire management, which is exactly what the refuge requires. Hiring the CCC's not only supports the promotion of valuable work ethic and experience for young adults but also offers an economical option. At the time a CCC worker was contracted out at \$17 per hour. Thus \$30,000 pays approximately for 1,764 work hours. 1,764 hours will supply you with a 10 person crew for 4 weeks worth of work. These work hours were spread out over the 2009 and 2010 work seasons, in order to best utilize the manual labor needed at the refuge.

The CCC's not only helped control and remove invasive plants for habitat restoration and for fire management purposes, but they also installed a new barbed wire fence in order to expand the grazing program at the refuge. In the before and after pictures below you can see an area at the Sardis Unit that was cleared of vegetation by the CCC's, in order to create more habitat for the Lange's metalmark butterfly and the two endangered plants. The Napa CCC crew provides much needed manual labor at the refuge that cannot always be provided by volunteers and the limited refuge staff. Their contribution to the conservation of the endangered species at the Antioch Dunes NWR has been invaluable for the past four years.



Before (on left) and after picture of Sardis Unit section where CCC's thinned out coyote bush to create more habitat for endangered species



Napa Center California Conservation Corp members at Antioch Dunes NWR

Allied Waste Disposal Dumpsters

The CVPIA HRP also funds dumpsters used to remove non-native invasive plant material from the Antioch Dunes NWR. We do not have a location to discard the waste and we do not burn the vegetation on site, so paying Allied Waste annually is necessary in order to control invasive plants at the refuge. The U.S. Fish & Wildlife Service Refuge staff, volunteers and California Conservation Corp members fill dumpsters rented from Allied Waste with invasive plant material that has been pulled or gathered throughout the refuge. We use garbage bags, garbage cans and tarps to carefully collect invasive plant material from around the refuge in order to reduce the amount of seeds from being further dispersed. FWS refuge trucks or CCC trucks are used to transport the invasive plant material around the refuge to the dumpsters. Once the dumpsters are full they are then picked up by Allied Waste and dumped at a green waste dumping site in Contra Costa County.



California Conservation Corp members and volunteers fill an Allied Waste dumpster with invasive plants

In 2009 and 2010 approximately 40,020 lbs of invasive plant material was removed from the Antioch Dunes NWR in Allied Waste dumpsters (Table 1). The CVPIA HRP granted funds paid \$3,065.77 towards the Allied Waste dumpsters in 2009 through 2010.

Sand Dune Restoration

Sand dune restoration at the Antioch Dunes NWR from 2009 through 2010 was put on hold until a clean source of sand could be identified and acquired. In 2008 the CVPIA HRP funded the purchase of sand for dune restoration on the Stamm Unit. 80 Truckloads of 20 cubic yards of Oakley sand, totally 1,600 cubic yards were purchased and delivered to the refuge for approximately \$28,000. The sand was purchased from a local source of sand 7 miles away from the refuge. It was assumed that the sand would not be cleaned of vegetation, but would have similar vegetation as the refuge. The sand was then dispersed in the Hard Pan 2 management area of the Stamm Unit and later the host plant for the endangered Lange's metalmark butterfly was planted on the newly created dunes. In 2010 a number of LMB larvae

were released onto the host plants on these new dunes. Currently there is a large stand of naked-stemmed buckwheat on the sand numbering over 500 plants. There are also a hand full of the endangered Contra Costa wallflower and Antioch Dunes evening primrose on the newly created dunes, but we have not yet counted LMB adults on or near the host plants on the new dune site.

This 2008 project did provide a new source of sand for the planting of the host plant and the endangered plants and it was a successful project. However, refuge staff decided that the invasive plant infestation must be first eradicated prior to bringing in new sand. The problem we ran into with the previous sand dune restoration was that a whole management area or several acres of sand must first be cleared of invasive plant material prior to bringing in the new sand. Otherwise the new sand dune will quickly be inundated with invasive plant material within one to two years. Currently, refuge staff is working with partners to attain large amounts of sand from several different locations. Those options include sand from the Rich Island Duck Club on Simmons Island, dredged sand spoils from the Port of Stockton, and/or sand excavated from the PG&E parcels that border the Sardis Unit. A method called horizon flipping that has been used successfully at Point Reyes National Seashore would be used to excavate clean sand from the neighboring PG&E parcels. The FWS staff is also looking to clear larger parcels of vegetation in preparation of new sand material. So, although the FY 09 FY10 proposal allocated \$30,000 towards the purchase of sand for restoration, no sand was purchased or acquired during this time period. Instead these funds were re-allocated towards much needed habitat restoration and invasive plant control by the California Conservation Corp. There is a complete budget re-allocation table (Table 2) on page 20 that presents this information. We plan on continuing the sand dune restoration program in the near future.

Grazing Program

The grazing program at the Antioch Dunes NWR was funded by the CVPIA HRP and is a great program that has helped to control invasive plants (grasses and winter vetch in particular) and increased the amount of bare sand within the grazing pens. We have also noted an

increase of host plant recruitment in these grazed areas at the refuge. We would like to continue this program and expand it by five more acres on the Stamm Unit. In 2009 the CCC's installed another barbed wire fence in preparation to expand the grazing program onto the Scarified and South of Path management areas on the Stamm Unit (please see Map 2 in the appendix). The CVPIA HRP allocated \$20,000 to the grazing program on the refuge and \$19,821.63 was used up by the Program. Stephanie Larson from the University of California, Davis Agriculture & Natural Resources Department was contracted to run the grazing program and to produce a report on the experimental grazing as a management tool for the refuge. She produced reports in 2008, 2009 and a Final Report in 2010. These reports can now be used to continue and expand the grazing program at the Antioch Dunes NWR as a management tool for controlling non-native invasive plants. The details of the cattle grazing timing, and grazing pressure can be found in the reports completed by Mrs. Larson. The Final Report is attached to the end of this document in the appendix. Copies of the previous reports can be attained from the U.S. Fish & Wildlife Service office for the Antioch Dunes NWR.

Below is a picture of the grazed land on the left side of the barbed-wire fence, and the ungrazed land on the right hand side. You can see that the cattle did a great job controlling the grass and vetch. However, the grazed areas must still be managed after the cattle are removed from the site. Once they reduce the amount of vetch and grass in a pen they are moved to another pen. If they are left too long in a pen then you run the risk of the cattle trampling more endangered plants and damageing more host plants. Once they are removed and the grass and vetch is grazed down, other invasive plants such as yellow starthistle and Russian thistle in the seed bank express themselves. And so we must use other methods of controlling these invasive plants later in the summer. After graxing is complete the cattle waste is removed by staff. Future grazing will now be combined with seeding of the endangered plants and the host plant to increase the amount of these desired plants and to displace the non-native invasive plants on the site.



CVPIA HRP funded cattle grazing in April and May 2010 helps control vetch and other invasive plants at Antioch Dunes NWR



Cattle waste collected from grazing area disposed of in Allied Waste dumpsters

Host plant Production

The production of Naked-stemmed buckwheat (*Eriogonum nudum psychicola*) is a critical part of the habitat restoration for the endangered Lange's metalmark butterfly. The Fish & Wildlife Service interns and staff produce a small amount of buckwheat annually at the FWS Complex in Fremont. Both the South Bay and North Bay facilities also produce other native and endangered plants for other refuge sites. So we are currently limited in space and resources. We are currently looking to expand the green house and shade house facilities at the North Bay office in Petaluma, in order to start growing the buckwheat and endangered plants in the North Bay. Currently we contract out the production of the host plants to the North Coast Native Nursery (NCNN).

The CVPIA HRP grant proposal allocated \$20,000 towards the propagation of the naked-stemmed buckwheat plants. We decided to use half of that amount (\$10,000) to produce 2,000 host plants for planting at the refuge and to support the LMB propagation program. We made this decision because we had previously contracted the NCNN to produce 8,000 host plants for the refuge with the support of previous CVPIA HRP grants. 6,500 host plants from the previous 8,000 host plants were planted at the Antioch Dunes NWR by volunteers, high school kids, interns and refuge staff. Approximately 1,000 of those previous host plants were transferred to the Urban Wildlands Group for the LMB propagation program. The other 500 host plants died during transportation or while being held in the shade house at the refuge office. At the time we felt as though we transplanted enough host plants to the refuge and could only handle 2,000 more plants. We re-allocated the funds towards the rental of Allied Waste dumpsters and towards the LMB propagation program. 1,600 of the host plants produced were planted at the Antioch Dunes NWR and 250 host plants were transferred to the Urban Wildlands Group for the LMB propagation program.

The North Coast Native Nursery has been a great partner in producing healthy and high quality naked-stemmed buckwheat plants for the refuge and the LMB propagation program. However, the cost of contracting this work out is expensive (\$5 per plant) and we are currently looking to do most of this production by expanding our refuge facilities and hiring an intern to manage the nursery at our North Bay office.



Naked-stemmed buckwheat plants produced by the North Coast Native Nursery

Volunteers and Outreach Work



Brownies SU 322 broadcast naked-stemmed buckwheat seed in 2010, and volunteers help pull vetch at Antioch Dunes NWR

A large portion of the work completed at the Antioch Dunes NWR is completed by our great volunteers and interns. This includes local high school kids from Deer Valley High, Antioch High, and Pittsburgh High School; as well as Cub Scouts, Brownies, community service workers and club members. Since the refuge staff is limited we are very fortunate to have a great group of volunteers that have donated thousands of hours of often strenuous work to the refuge in order to help protect and conserve these three endangered species that are unique to the Antioch Dunes NWR.

Volunteers have helped the refuge plant the endangered Contra Costa wallflower and Antioch Dunes evening primrose, and thousands of naked-stemmed buckwheat plants that have been produced from the CVPIA HRP funds. Cub Scouts and Brownies have helped to seed the desired plants into cleared sand on the refuge. Multiple high schools have visited the refuge to help us control invasive plant, in order to protect them and to promote the recruitment of more desired plants. In 2009 and 2010 many of these outstanding volunteers donated 2,377 hours of work in order to help the FWS staff protect and conserve the endangered species at the refuge.

Lange's Metalmark Butterfly Propagation

In 2005 the number of endangered Lange's metalmark butterflies dropped down to 232 individuals. The low population numbers triggered the U.S. Fish & Wildlife Service to set up a biological consultation with lepidopterists concerning the low LMB population (see Fig 1 under project results). It was determined that an LMB propagation program should be created in order to help increase the population of Lange's metalmark butterflies. The captive population of LMB would also act as an insurance population in case a catastrophic event (such as a wildfire) wiped out the remaining wild population at the Antioch Dunes NWR. In 2006 the USFWS Ecological Services office in Sacramento selected lepidopterist Dr. Travis Longcore and The Urban Wildlands Group to lead the Lange's metalmark butterfly Propagation Program. The Urban Wildlands Group is also currently contracted by the USFWS to propagate the endangered Palo Verdes blue butterfly, and thus had a successful track record for propagating endangered butterflies. The propagation team includes Dr. Jana J. Johnson and lepidopterist Ken Osborne.

The propagation program started in late August of 2007 when lepidopterist Ken Osborne collected the first five female LMB for the program from the Antioch Dunes NWR (Table 2). The LMB propagation team has been fully funded by the CVPIA HRP grant from 2007 to 2010. Since 2007 the LMB Propagation team or Team LMB has captured 14 female LMB. That includes 5 in 2007, 0 in 2008, 4 in 2009, and 5 in 2010. From those 14 LMB they have produced 2,086 LMB larvae in the propagation labs located in Moorpark, CA. The team released 30 adult LMB onto the Stamm Unit of the Antioch Dunes NWR in 2008. They also released 25 LMB larvae and 5 LMB pupae in 2008. In 2009 the team decided to only release larvae and released 88 LMB larvae onto the Stamm Unit. And then in 2010 the team released 119 LMB larvae onto the Stamm Unit. The LMB propagation team has released a total of 267 LMB onto the Stamm Unit of the Antioch Dunes NWR over the last four years (Table 6 in Results).



On the left Ken Osborne captures female LMB at the Antioch Dunes NWR in Aug of 2009. Captured LMB in container on right.

The Lange's metalmark butterfly has a lifecycle that is completely dependent on their host naked-stemmed buckwheat plant. The buckwheat bloom in August and September and so the LMB simultaneously emerge as adults to nectar on the host plants, mate and lay their eggs on the buckwheat. The most LMB emerge as adults in late August, usually the last week of August. We call this the peak week and use the previous year's peak week counts to track the health and trends of the LMB population. The peak week counts are graphed on Figure 1 going back to 1986 when the USFWS started monitoring the LMB population. Every year in August and September the USFWS biologist Susan Euing leads a team of FWS staff and volunteers to survey for the LMB at the refuge twice a week (once at the Stamm Unit and once at the Sardis Unit). After the peak emergence week the propagation team mobilizes to the refuge and captures a safe amount of LMB according to the number that has been currently counted. Once the LMB are captured, the propagation team carefully places them in containers that are fastened to the host plant and transfer them to the propagation labs at the Moorpark College Campus in Moorpark California (capture & containers pictured above).



Dr. Jana Johnson shows an LMB container to FWS biologist Susan Euing on May 30 2009

Once the captured female LMB are transferred to the propagation labs in Moorpark they are carefully watched and cared for as they lay their eggs on the naked-stemmed buckwheat that are provided to them. The Lange's metalmark butterflies usually last 7 to 10 days as an adult in the wild. During this time they mate and lay their eggs on multiple host plants. However, in captivity the propagation team can care for the LMB and extend their adult lives up to 14 - 18 days long. The absence of predators and parasitoids allows the propagation team to gather more LMB eggs from the captured females.

In the wild and in captivity the eggs that are laid on the host plants do not hatch until four months later in January and February. At this point the tiny LMB larvae begin to feed on the top layer of the leaves of the host plant. They go through 5 instars or growth spurts between March and July until they finally pupate and emerge as adult butterflies in August and September. While they are in larval form they require lots of green naked-stemmed buckwheat plant leaves for consumption. The USFWS has been growing and contracting the growth of the host plant for out planting to the refuge and also to provide host plants to the propagation program. It is in late June when the Urban Wildlands Group releases the propagated LMB larvae to the Antioch Dunes NWR. The propagation team released 88 LMB larvae in 2009 and 119 LMB larvae in 2010 onto the Stamm Unit of the Antioch Dunes NWR (Table 6 & 7).

In May of 2009 USFWS biologist Susan Euing and USFWS Wildlife Refuge Specialist Louis Terrazas toured the Moorpark LMB propagation laboratory. Dr. Jana J. Johnson displayed and described the painstaking process and rigorous protocol necessary for propagating the Lange's metalmark butterfly. The LMB propagation labs are organized and monitored meticulously, carefully and professionally by the Urban Wildlands Group staff.

In September of 2009 the Moorpark labs were threatened by a nearby wildfire and had to be evacuated. All LMB were safely evacuated and returned to the labs after the threat of fire had passed. Pictures below show some of the effort it took to carefully load up all of the LMB in their containers and temporarily move them to a safe site.

LMB Evacuation 9/22/2009





Dr. Jana Johnson releases 119 LMB larvae at the Antioch Dunes NWR in the summer of 2010

Project Results

Budget

The budget proposal for the 2009 and 2010 CVPIA HRP was altered from the original budget proposal. The USFWS had originally planned on conducting sand dune restoration, but decided to postpone this program until we had located a better source of sand and had eradicated much of the non-native invasive plant vegetation on the refuge. The sand dunes restored in the past were soon covered by invasive plants that surround the restoration area. The original proposal had allocated \$30,000 to sand dune restoration. This was re-allocated into habitat restoration and invasive plant management by the California Conservation Corp.

The host plant propagation had been originally allocated \$20,000 in the proposal. This was reduced by half. The USFWS felt that they had previously produced enough of the host plants (8,000 buckwheat plants in 2008) and decided to re-allocate the funds into the rental of dumpsters for the purposes of removing non-native invasive plant material. The LMB propagation program exceeded the original proposal by \$9,276. These funds were used to pay for extra work hours, including the unexpected hours during the emergency evacuation of the Moorpark LMB propagation labs in September of 2009.

The indirect costs were reduced from \$9,276 in the original proposal to \$7,112.60. Since the LMB propagation exceeded the original budget, the remaining funds from the indirect costs (\$2,163.40), and the grazing program (\$178.37), and the host plant production went into the rental of Allied Waste dumpsters. The budget alterations are all displayed in the budget re-allocation table below (Table 2). The original budget proposal can be found in the appendix (Table A).

Table 1: USFWS Funds

Funds & Partners	\$ Used	Notes
Coastal Grant Fund	\$5,000.00	Restoration work & Equipment
Wildland Urban Interface	\$30,000.00	Contra Costa Co Fire, Fire Prevention
Wildland Urban Interface	\$25,000.00	CCC's fire & invasives management
FWS Staff hours	\$232,000.00	FWS Staff Hours & L. Terrazas Hours
FWS Total Funds	\$292,000.00	Total for FY 2009-2010

Table 2: Budget Re-allocation for the CVPIAHRP Grant for Antioch Dunes NWR

Project Activity	Partner	Notes	Proposal	Adjustment	Final Adjusted Budget
LMB Propagation	UWG	Altered	\$46,380	9,276	\$55,656.00
Sand Dune Restoration		Cancelled	\$30,000	-30,000	\$0.00
Cattle Grazing Project	UC Davis	Conducted	\$20,000	-178.37	\$19,821.63
Host Plant Propagation	NCNN	Altered	\$20,000	-10,000	\$10,000.00
Invasive Plant Control	CCC's	Added	0	30,000	\$30,000.00
Invasive Plant Removal	Allied Waste	Added	0	3,065.77	\$3,065.77
Indirect Costs	USFWS	Altered	\$9,276	-2163.4	\$7,112.60
Total			\$125,656		\$125,656.00

Habitat Restoration

In 2009 and 2010 the United States Fish & Wildlife Service provided staff hours and paid intern hours that amounted to approximately \$232,000. This includes habitat restoration work completed by staff, herbicide spraying, mowing, and coordination of the grazing, host plant and LMB propagation programs. Volunteer hours and community service worker hours are broken

down and displayed in Table 4 below. Total volunteer hours for 2009 and 2010 were approximately 2,377 hours.

In 2009 and 2010 10 acres of the Antioch Dunes NWR was restored. 77.25 acres of invasive plants were controlled in 2009 and 2010. Also, 24 acres of invasive plants were controlled using herbicides. In 2009 and 2010 40,020 lbs of invasive plant material was removed and hauled away in Allied Waste dumpsters (Table 3). Table 5 contains highlighted habitat restoration accomplishments for 2009 and 2010. There is an adjusted timeline taken from the original proposal in the appendix that contains highlighted tasks and events from 2009 & 2010 (Table B).

10 acres were grazed by cattle in both 2009 and 2010. The 2010 Final Grazing report written by Stephanie Larson from the UC Davis Agriculture & Natural Resources Cooperative Extension office has been attached to the appendix. The 2008 and 2009 Grazing Reports are available upon request.

Table 3: Allied Waste Disposal Dumpster Loads in 2009 & 2010

Date	Site	Weight lbs	
6/23/2009	ADNWR	940	357.82
6/26/2009	ADNWR	980	357.82
7/28/2009	ADNWR	1280	357.82
7/31/2009	ADNWR	940	357.82
9/2/2009	ADNWR	1920	357.82
9/4/2009	ADNWR	3820	357.82
10/1/2009	ADNWR	1400	357.82
10/2/2009	ADNWR	4680	357.82
7/16/2010	ADNWR	1880	357.82
7/16/2010	ADNWR	3880	357.82
8/16/2010	ADNWR	1320	357.82
8/16/2010	ADNWR	8680	357.82
9/16/2010	ADNWR	540	357.82
9/16/2010	ADNWR	4380	357.82
11/17/2010	ADNWR	3380	357.82
	Total Weight	40,020	5,367.30

Table 4: Volunteer Work Hours

Group	Hours
Volunteer Hours	1,462
Community Service Volunteer Hours	915
Total Volunteer hours	2,377

Table 1: Habitat Restoration & LMB Propagation Progress

Activity	Partners	2009	2010	Total
Acres Restored	FWS & CCC	4	6	10
Acres Grazed	U.C Davis Ag Ext	10	10	20
Acres Mowed	FWS	9	9	18
Acres Sprayed with Herbicides	FWS	12	12	24
Acres of Weeds Controlled	FWS & CCC & Vols	38.25	39	77.25
Invasive Plant Material Removed	Allied Waste Disposal	15,960	24,060	40,020
Sand Dune Restoration	Roy Reeves Sand	0	0	0
Naked-stemmed buckwheat Plants Planted	FWS & Volunteers	1,000	600	1,600
Naked-stemmed buckwheat Plants Seeded	FWS & Volunteers	100.14 g	20 grams	120.14
Naked-stemmed buckwheat plants produced	North Coast Native Nursery	1000	1000	2,000
LMB Larvae Released on Stamm Unit	Urban Wildlands Group	88	119	207

LMB Propagation

The Urban Wildlands Group successfully captured 4 female LMB at the refuge in 2009 and 5 female LMB in 2010. From those 9 captured LMB they collected and produced 503 eggs in 2009 and 1,289 eggs in 2010. Ultimately they successfully released 88 LMB larvae in 2009 and 119 LMB larvae in 2010 at the Stamm Unit. Table 6 displays highlighted LMB propagation

accomplishments from 2007 to 2010. Table 7 contains the LMB release data from June 21st of 2010. All released LMB larvae were placed onto healthy adult naked-stemmed buckwheat plants. Many of those plants had been produced and funded by the CVPIA HRP grant. Map 2 shows the locations of the management areas on the Stamm Unit. Map 4 is a USGS produced map that shows the location and intensity of the naked-stemmed buckwheat plants, the endangered Contra Costa wallflowers, Antioch Dunes evening primrose and other nectar plants.

Table 6: LMB Propagation Progress

Year	LMB 2006	LMB 2007	LMB 2008	LMB 2009	LMB 2010
LMB Captured	NA	5	0	4	5
Eggs Produced	NA	NA	294	503	1289
LMB Released	NA	NA	60	88	119
Peak Count	45	89	131	46	28
Stamm LMB	5	14	10	20	20
Sardis LMB	144	192	358	99	75
Total LMB	149	206	368	119	95

Table7: LMB Larvae Released on Stamm Unit by Dr. Jana Johnson & The Urban Wildlands Group June21st 2010

Buckwheat plant #	LMB Released	Meters North	Meters East	Notes
WV-1	4	4208080.6	605828.42	West Vineyard Management Area, grazed area
WV-2	3	4208081.57	605832.49	Naked-stemmed buckwheat had been grazed
WV-3	3	4208084.71	605839.55	All GPS Points taken in UTM's, WGS1984
WV-4	3	4208090.76	605851.71	
WV-5	3	4208083.5	605830.93	
WV-6	4	4208088.33	605844.67	
HP4-1	3	4208220.45	605811.86	Hard Pan 4 MA
HP4-2	3	4208221.29	605826.72	NS buckwheat had been recently planted in 08/09
HP4-3	3	4208221.61	605817.52	
HP4-4	4	4208218.71	605832.64	
HP4-5	3	4208213.84	605832.01	
HP4-6	5	4208219.59	605835.99	
SOP-1	4	4208265.29	605594.79	South of Path MA
SOP-2	4	4208265.73	605586.6	NS buckwheat planted in 08/09
SOP-3	4	4208266.87	605591.05	
SOP-4	4	4208265.97	605575.01	
95D-1	4	4208281.52	605595.15	95 Dunes MA
95D-2	4	4208283.61	605601.64	Heavy winter vetch area
95D-3	4	4208287.78	605612.82	
95D-4	4	4208292.12	605592.44	
HP2-1	4	4208333.94	605561.44	Hard Pan 2 MA
HP2-2	2	4208328.25	605563.43	New sand and NS buckwheat from 08/09
HP2-3	7	4208323.43	605567.02	Thick NS buckwheat
HP3-1	4	4208271.1	605896.59	Hard Pan 3 MA
HP3-2	4	4208268.43	605893.1	NS buckwheat planted by Deer Valley High 2007
HP3-3	4	4208263.37	605887.13	heavy vetch
NE-1	4	4208223.14	606012.92	North East MA
NE-2	4	4208215.85	606016.25	Heavy vetch area
NE-3	6	4208214.11	606012.52	
NE-4	7	4208212.54	606005.29	
Total LMB Released	119			

Figure 1: Annual Peak Counts for Lange's Metalmark Butterfly at Antioch Dunes NWR

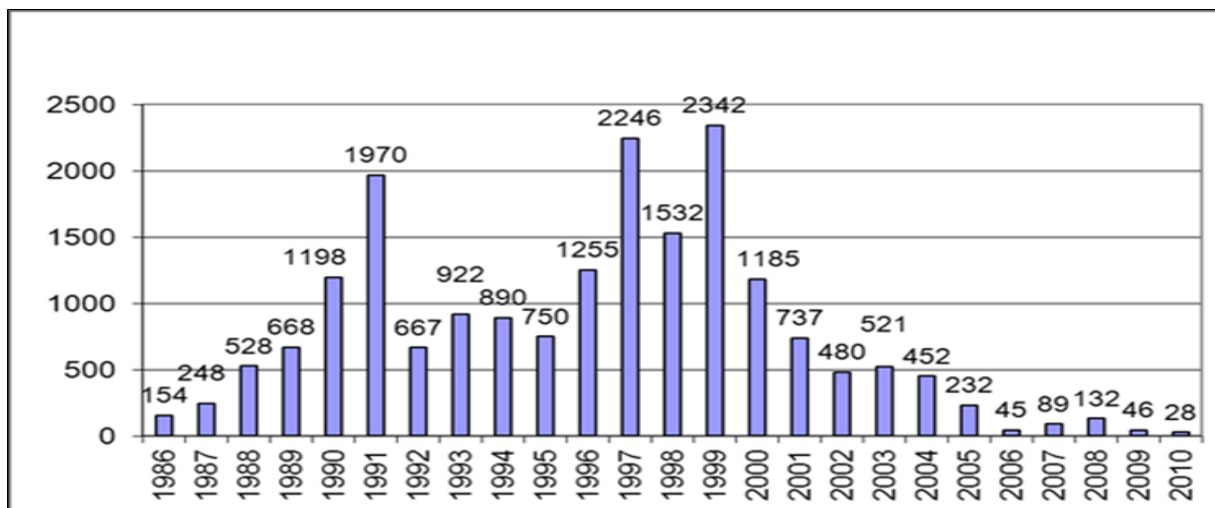


Figure 2: Antioch Dunes evening primrose counts between 1985 and 2010

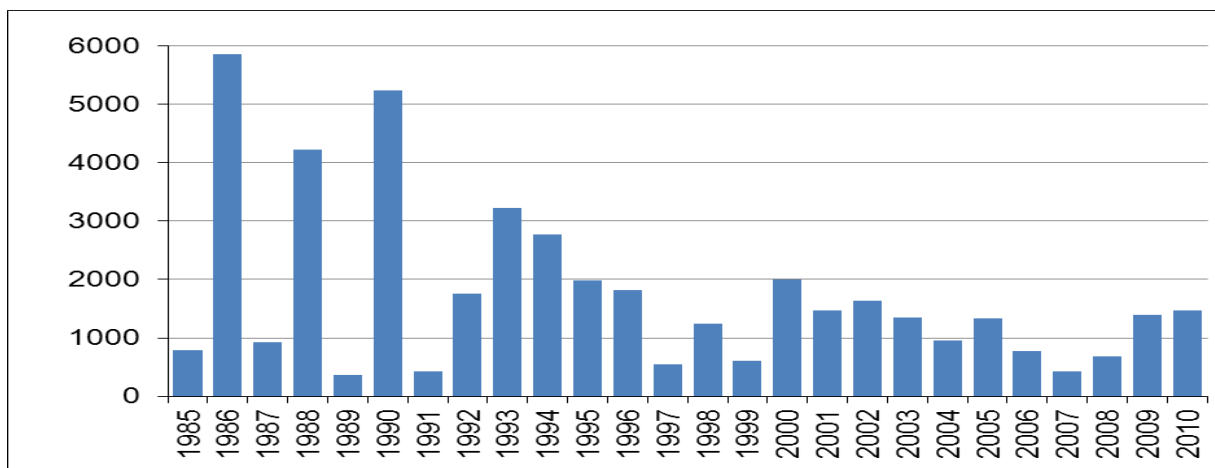
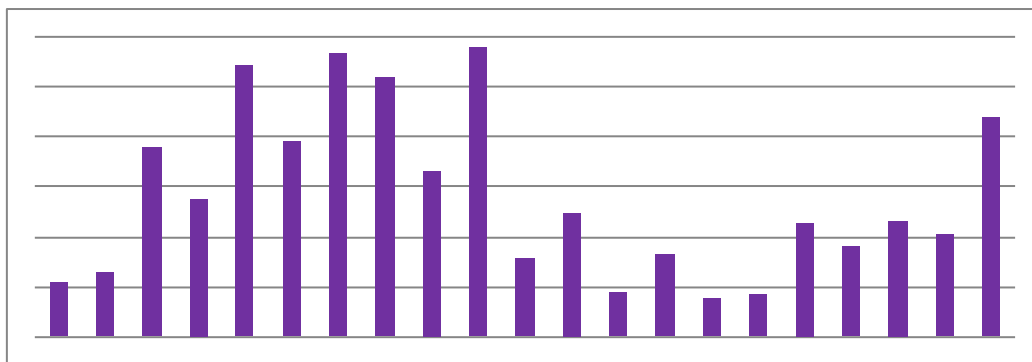


Figure 3: Contrast Costa wallflower counts between 1990 and 2010



Discussion

The funds granted to the US Fish & Wildlife Service (\$125,656.00) for the financial years off 2009 & 2010 were crucial to the success of the habitat restoration at Antioch Dunes National Wildlife Refuge and the Lange's metalmark butterfly propagation program. From 2007 through 2010 the Central Valley Project Improvement Act Habitat Restoration Program fully supported the LMB propagation program at the refuge. Without the support of the CVPIA HRP this crucial program may not have been started, or at the very least would have been delayed, and the state of the Lange's metalmark butterfly would be worse. The LMB propagation program headed by Dr. Travis Longcore and the Urban Wildlands Group has established a LMB propagation manual and protocol that not only benefits the LMB, but can be used as a model for future rare butterfly propagation programs. The propagation program has expanded the knowledge of the LMB lifecycle. Since the LMB have been held in captivity much has been discovered about the egg stage, larval stages and behavior, pupal and adult stages. The propagation program also acts as an insurance policy, in case there is a catastrophic event at the refuge that could potentially wipe out the last remaining wild population of the LMB. The propagation team has successfully released 267 total LMB (30 adults, 5 pupa, & 232 larva) over the last four years.

Although the population of LMB has not recovered, it has been crucial in helping to increase the amount of LMB in the wild. The LMB population is dangerously low (95 total wild LMB in 2010), and so the more LMB there are available to mate, the more likely it is that the population will recover. The LMB propagation program must continue to function until the population has increased above 350 total LMB in one adult flight season, and or until the population is considered stable. However, a greater effort to restore the habitat at the Antioch Dunes NWR must be achieved. Due to the low staff numbers and lack in resources at the refuge, we must be able to attain funds in order to increase the habitat restoration. The funds granted to the refuge for habitat restoration have been extremely helpful, but the refuge actually requires more in order to appropriately restore the habitat on the refuge. Of the total \$125,656 granted to the refuge, only \$30,000 or 24% was used on habitat restoration and

invasive plant management that is desperately required at the refuge. The Antioch Dunes NWR could easily use \$100,000 annually just on invasive plant management alone. Funds must be sought in order to hire the proper amount of staff that are need to appropriately maintain the refuge habitat. Two biological technicians and one intern should be hired to help fulfill a conservation need. The FWS refuge staff will continue to search for partnerships and grants in order to help expand the habitat restoration efforts at the Antioch Dunes NWR.

In 2009 the USFWS Sacramento regional office drafted a contract between the Antioch Dunes NWR and the Pacific Gas & Electric Company that borders the refuge Sardis Unit. This safe harbor agreement allows the refuge to help expand the populations of the three endangered species on the bordering PG&E property. At the same time the contract assures PG&E that they can conduct routine operations and maintenance on their property without penalty as long as there is a net conservation benefit to the endangered species. The FWS will use this agreement as a model to establish agreements with the other neighbors of the Antioch Dunes NWR. Setting up more contracts in the future will better allow the refuge staff to work with their neighbors in an effort to better protect the refuge from further invasive plant infestation and from the threat of wildfires. The PG&E SHP is available upon request.

Recently the USFWS refuge staff and ecological services staff have worked together to produce an Antioch Dunes NWR Management Plan. The plan will help guide the conservation efforts for the Lange's metalmark butterfly. The management plan highlights 4 main tasks for the refuge. Those tasks are maintaining the LMB propagation program, continuing and greatly increasing the habitat restoration on the refuge, attaining multiple safe harbor agreements with the neighboring property owners, and for regional ecological services to attain conservation benefits for the Lange's metalmark butterfly. The UWFWS is working hard to improve the Antioch Dunes NWR and the habitat for the endangered species that call it home.

We are grateful for the help and partnership we have had with the Bureau of Reclamation for the last 4 years. Thank you for your support.

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_____ 2008. Lange's metalmark butterfly (*Apodemia mormo langei*) Antioch Dunes evening-primrose (*Oenothera deltoides* subsp. *howellii*) Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*) 5-Year Review: Summary and Evaluation. Sacramento Fish and Wildlife Office, Sacramento, California.

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.....2010. Lange's Metalmark Butterfly Biological Report for 2010. (*Attached to Appendix*)

United States Geological Survey. 2009. Antioch Dunes Stamm 2008-2009 Plant Map

Appendix

Table A: Budget Table.....	30
Table B: Project Timeline.....	32
Map 1: Antioch Dunes NWR Map.....	34
Map 2: Stamm Unit Map.....	35
Map 3: Sardis Unit Map.....	35
Map 4: USGS Antioch Dunes Stamm 2008-2009 Plants.....	36
2010 Lange's Metalmark Butterfly Annual Report.....	37
2010 Final Grazing Report.....	47

Table A: Budget Table Based on FY 2009 / 2010 proposal.

COST ITEM DESCRIPTION	COMPUTATION		RECIPIENT COST SHARE	RECLAMATION FUNDING	TOTAL COST
	Unit/Hour	Quantity			
<u>SALARIES AND WAGES</u>					41,000
Science Director (Longcore)	60	100		6000	
Entomological Consultant (Osborne)	100	30		3000	
Project Scientist (Johnson)	40	200		8000	
Student Managers (Lansing, Renner)	20	600		12000	

Student Workers (6)	15	800		12000	
<u>FRINGE BENEFITS</u>					00
Full-time employees					1,380
Part-time employees (Longcore only)				1380	
<u>TRAVEL</u>					2,000
SoCal-Antioch Habitat Assessment				500	
Moorpark-Antioch Larval Release				500	
Moorpark-Antioch Adult Release (2 parties)				1000	
Moorpark					00
<u>EQUIPMENT</u>					00
<u>SUPPLIES/MATERIALS</u>					2,000
Rearing supplies (consumable containers, netting, mating boxes, etc.)				1500	
Foodplant Care and Provision (pots, soil) at Moorpark.				500	
<u>CONTRACTUAL</u>				46,380	46,380
<u>ENV & REGULATORY COMPLIANCE</u>					00
<u>OTHER: to include</u> Grazing Project (20,000), Buckwheat Propagation (10,000),			143,000	70,000	213,000

CCC's , & Allied Waste					
Reporting					00
TOTAL DIRECT COSTS			143,000	116,380	259,380
INDIRECT COSTS - 20%				9,276	
TOTAL ACTIVITY COSTS			\$ 143,000	\$125,656	\$ 202,656

Table B Project Timeline: Activities accomplished within 2009 & 2010 funding (based on proposal timeline)

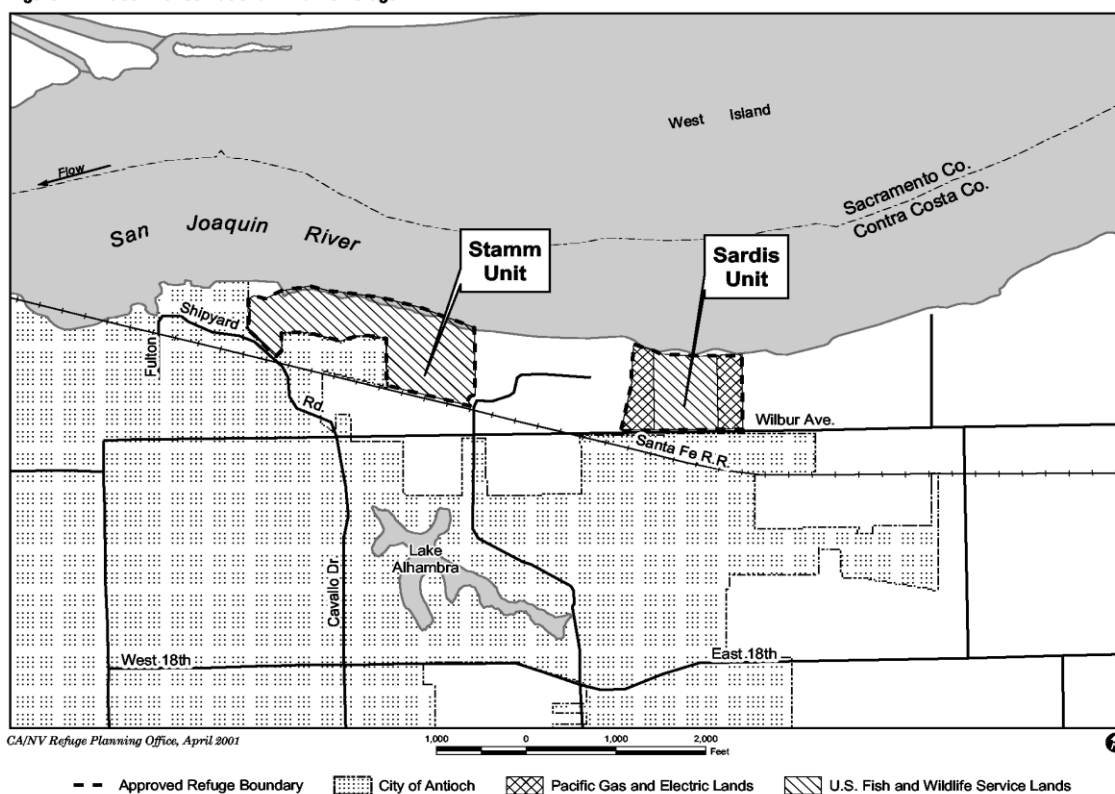
Approximate Dates and Task	Accomplishments & Notes
Feb-09	
Antioch Dunes NWR & LMB Propagation display at Flyway Festival	Approximately 1,000 visitors
Mar-09	
Place cattle into pastures	Yes, cattle released (8 animals) April -May
Spring invasive plant control on winter vetch & grasses	Yes, conducted by staff, vols & CCC's
Apr-09	
Remove cattle from pastures	No, cattle removed in May
Conduct evening primrose survey	Yes, conducted mid April
Contra Costa Wallflower surveys	Yes, please see Fig 3
May-09	
Conduct Antioch Dunes evening primrose surveys	Yes, please see Fig 2
Team LMB features LMB propagation at Los Angeles Bug Fair	Approximately 3000 - 4000 visitors
Jun-09	
Urban Wildlands Group releases 88 LMB larvae onto Stamm Unit	June 27 2009
Aug-09	
Start annual Lange's survey	Yes, LMB surveys conduct Aug -September
Release captive adult Lange's metalmark butterflies	No, LMB release was June 27
Propagation of LMB, mating of adults and isolation of egg masses	Yes, 5 female LMB captured Aug 29th

Sep-09	
Complete Lange's survey	Yes, please see Results Table 2, Fig 1
Propagated LMB in labs in Moorpark evacuated due to fire	Sep 22, No LMB lost
Oct-09	
Clear invasive plants	Yes, conducted throughout year
Nov-09	
Anticipate larvae will hatch from eggs at Moorpark	Hatch observed in January & February
Receive 100 truckloads of sand at Stamm Unit	No, sand restoration put on hold
Dec-09	
Out planting using volunteers	Yes, conducted throughout Fall & winter
Jan-10	
Supply Moorpark with Buckwheat food plant	Approx 1000 plants supplied in July of 2009
Feb-10	
Antioch Dunes NWR & LMB Propagation display at Flyway Festival	Approximately 1,000 visitors
Outplanting using volunteers	Yes, conducted throughout Fall & winter
Mar-10	
Release cattle into pastures as part of annual management plan	Yes, cattle released (8 animals)
Spring invasive plant control on winter vetch & grasses	Yes, conducted by staff, vols & CCC's
Apr-10	
Contra Costa Wallflower surveys	Yes, please see Fig 3
Remove cattle from pastures	No, cattle removed on May
May-10	
Conduct Antioch Dunes evening primrose surveys	Yes, please see Fig 2
Jun-10	
Supply Moorpark with Buckwheat food plant	Yes, approximately 300 plants
Release Lange's larvae at Stamm unit	Yes, 119 LMB larvae released onto Stamm
Jul-10	
Anticipate Lange's larvae will enter pupal stage	Yes
Aug-10	

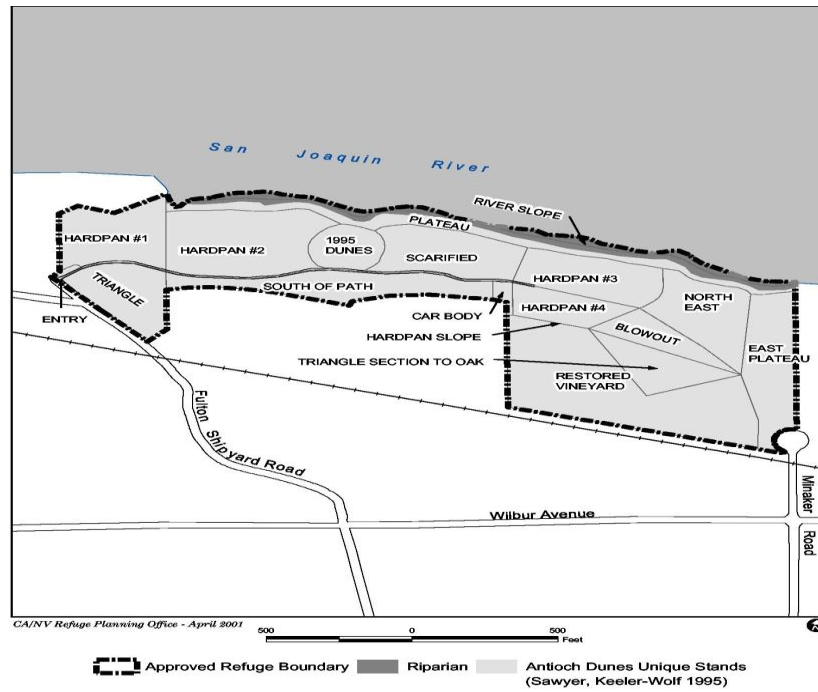
Release adults at refuge	No, LMB larvae release in June
Start annual Lange's metalmark survey	Yes, twice weekly Aug through Sept
LMB capture conducted	Yes, 5 female LMB adults captured
Sep-10	
Complete Lange's survey	Yes, please see Results Table 2, Fig 1
Oct-10	
Out planting using volunteers	Yes, conducted throughout Fall & winter

Map 1: Antioch Dunes National Wildlife Refuge

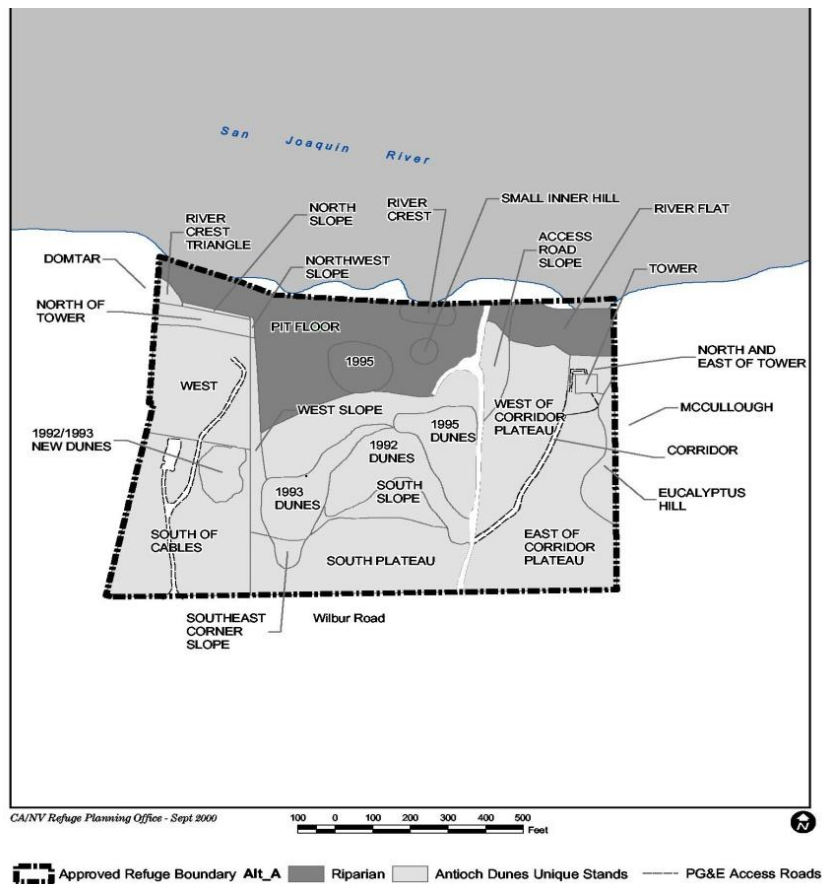
Figure 2. Antioch Dunes National Wildlife Refuge

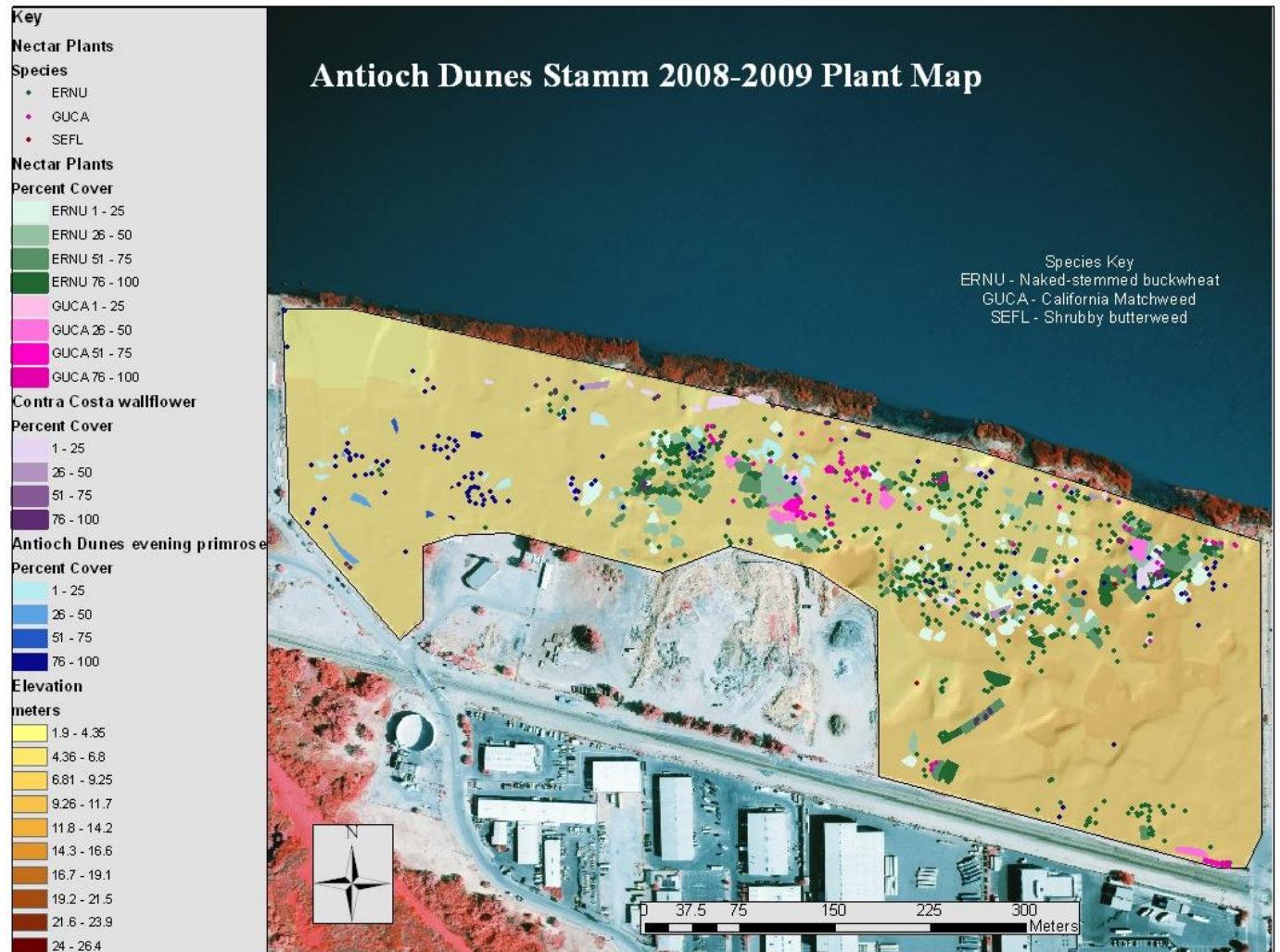


Map 2: Antioch Dunes National Wildlife Refuge Stamm Unit



Map 3: Antioch Dunes National Wildlife Refuge Sardis and PG&E Units







United States Department of the Interior

FISH AND WILDLIFE SERVICE

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April 27, 2010

To: The Files

From: Melanie Mancuso, Satellite Biology Intern, and Susan Euing, Refuge Biologist

Subject: 2010 Contra Costa Wallflower Survey

A two-day survey of the Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*), hereafter referred to as CCW or wallflower, was conducted by the US Fish and Wildlife Service (USFWS) on April 21 and 22, 2010 for both units (Stamm and Sardis) of the Antioch Dunes National Wildlife Refuge (ADNWR or the Refuge) and adjacent Pacific Gas and Electric (PG&E) properties, hereafter referred to as units. For the April 21 wallflower survey at the Stamm Unit, the participants were S. Euing, L. Terrazas, A. Donner, R. Crowe, M. Mancuso,

L. Zander, and T. Kask. The participants of the April 22 wallflower counts at the Sardis Unit were S. Euing, L. Terrazas, R. Crowe, M. Mancuso, A. Sturgess, A. Garibaldi, S. Gallegos,

and S. Lezer. The total wallflower count was 8,822, which included mature (blooming) and immature (non-blooming) plants.

Method

Annual surveys of blooming and non-blooming CCW are conducted during the peak blooming period on both of the Refuge units, Stamm and Sardis, and on adjacent Pacific Gas and Electric units which lie east and west of the Sardis Unit. This method will be continued until CCW numbers increase to the point that the surveys prove to be too labor intensive.

The survey is conducted by five to ten staff members, refuge interns, and volunteers (surveyors). A training session is conducted prior to each survey. Training includes:

1. How to properly identify the mature and immature Contra Costa wallflower plant.
2. How to identify and avoid harming naked-stemmed-buckwheat (*Eriogonum nudum auriculatum*) and the endangered Antioch Dunes evening primrose (*Oenothera deltooides* ssp. *howellii*) (primrose), as well as other native plants.
3. Learning the proper method to conduct the Contra Costa wallflower survey.

During the counts, all surveyors start at one end of a management area (MA) and spread themselves five to fifteen feet apart, depending on the density of CCW in a particular MA. The surveyors carry counters and record their observations while walking in a straight line, parallel to one another while constantly communicating to each other to avoid double-counting. Surveyors walk lines back and forth until the MA has been completely surveyed. Each participant reads out the count to the recorder and turns the counter back to zero before starting a new count. All management areas are counted using this method. Data is entered into a Microsoft Access database, and yearly graphs and summaries are written. Reports are submitted to the Service's Ecological Services Office annually and are also kept on file at the San Francisco Bay National Wildlife Refuge Complex.

Results

A total of 8,822 CCWs (2796 blooming and 6026 non-blooming) were counted at Antioch Dunes National Wildlife Refuge in April 2010. Table 3 displays the 2010 counts, which can easily be compared to previous counts beginning in 1984 in Tables 1 and 2.

Stamm Unit

A total of 2,453 CCW plants (918 blooming and 1,535 non-blooming) were counted in 2010 at the Stamm Unit. In 2009, a total of 827 plants were counted in the Stamm Unit. The 2010 numbers increased by 1,626 plants (197%). Of the sixteen management areas in the Stamm Unit, five decreased in number of CCWs from last year, and eight increased in number. The number of CCWs found in Hardpan 1, Blowout, and Scarified remained the same as the 2009 counts. River Slope had the greatest increases in 2010 in total plants, mature and immature plants from the previous year. In 2010 River slope had 1542 more plants overall than 2009, which included 105 blooming and 1437 non-blooming. On the contrary, River Plateau had the greatest decrease from 2009 with 67 fewer plants overall (52 blooming and 15 non-blooming). Carbody had 55 non-blooming CCWs counted last year and none counted this year, while South of Path had zero non-blooming CCWs last year and 53 this year.

Sardis Unit

A total of 2483 (384 blooming and 2,099 non-blooming) CCW plants were recorded in 2010 at the Sardis Unit. A total of 1076 were counted last year. This is an increase of 1,407 plants (131%). Of the eleven MAs surveyed, seven had an increase in CCW numbers, three decreased, and only the Small Inner Hill remained the same with no plants counted. The South Slope had the greatest increase in number with 1,272 (23 blooming and 1,249 non-blooming) more CCWs counted than last year. River Crest had the greatest decrease in numbers with 475 fewer plants counted this year. 1995 Dunes North had a large increase from last year (502) in CCW non-blooming plants. South Plateau had 68 blooming CCWs, and 1992 New Dunes had 34 blooming, both of which represent the greatest number recorded in these MAs in seven years. The numbers of plants found on the Pit Floor were 182 fewer than last year count.

PG&E East

A total of 3,879 (1,487 blooming and 2,392 non-blooming) CCW plants were recorded in 2010 at PG&E East. In 2009, a total of 2,214 (1443 blooming and 771 non-blooming) were recorded. This year's total represents an increase of 1,665 plants or 75%. All of the six MAs increased in number with the exception of the River Flat, where the number remained the same as last year with zero plants found. Of those MAs that increased in numbers, Eucalyptus Hill had the greatest increase from last year with an additional 1,159 CCW plants. The Tower area had a large increase of 553 blooming plants, but it also had a large decrease of 125 non-blooming plants. With 836 plants, the Tower had its highest number since 2003. The Corridor also had a large increase of non-blooming plants: 764 more than in 2009. However the number of blooming plants decreased by 42 from last year.

PG&E West

A total of 7 blooming plants and no non-blooming plants were counted on PG&E West. This represents no change in number as compared to the 2009 surveys. However, last year 7 CCWs were found on the North Slope. This year, none were found on the North Slope, but 7 were found on the Northwest Slope.

Discussion

The CCW count of 2010 was the second highest count since 1999 (Figure 1) and the fifth highest of all counts from 1984 to present (Tables 1, 2 and 3). Comparing 2010's count of 8,822 wallflowers to that of 2009, in which 4,124 wallflowers were counted, there was a significant increase of 114% or 4,698 plants. There was an increase of 316 or 13% in the blooming population and 4,382 or 267% in the non-blooming population. This large increase in CCW plants is most probably due to the increase of precipitation in the San Francisco Bay area over the last year. As seen in Figure 3, there was 18.05 inches of precipitation from May 1, 2009 to April 30, 2010. This is nearly twice the amount of precipitation from 2009, which had 9.44 inches. Other possible reasons for the increase in CCW numbers are more aggressive invasive plant control and annual planting of seeds and seedlings in 2010.

Starting in 2009, the blooming and non-blooming CCW plants were counted separately, similar to the Antioch Dunes evening primrose annual counts. Surveys conducted in previous years did not distinguish between the two. The plants have been categorized to better compare recruitment of seedlings with those propagated in the Fremont greenhouse and outplanted.

Outplantings of juvenile plants from the greenhouse help to support the wallflower populations. As seen in Table 4, 620 seedlings were outplanted into ADNWR between January and March, 2010. In the Stamm Unit, no non-blooming CCWs were found in either the River Plateau or Hardpan 3 even though seedling outplantings occurred in both of these units. In both Hardpan 4 of the Stamm Unit and Access Road of the Sardis Unit, fewer non-blooming CCWs were found during the counts than were actually planted.

The Contra Costa wallflower is a biennial plant. After germination of the seed, it develops in the first year into an immature seedling. The second year, the plant matures, flowers, seeds and senesces. However, it was observed that some first year seedlings grown in the Fremont greenhouse had matured (bloomed) by the following summer. This observation was noted in 2007-2010 (Euing, pers. obs. 2010), and might account for zero sightings of immature plants and increases of mature plants found in some MA's during the annual surveys. If time permits, a study on this observation will be conducted.

Besides outplanting of endangered and native plants and seeds into ADNWR, other efforts to help enhance the CCW populations included removing invasive plants by herbicidal, manual, and mechanical means as well as cattle grazing. In 2010, 8 head of cattle had free range between two MAs (West and East Vineyards) in the Stamm Unit. Although it is too early to correlate grazing to CCW numbers in these two MAs, the collective number of CCWs increased from nine found in 2009 to 21 found in 2010.

Changes in survey techniques have taken place since 2007. In the past, only those MAs that were historically known to contain CCWs were surveyed. Currently, all MAs at both the Stamm and Sardis Units are surveyed annually. Some changes such as boundaries, names, and sizes of MAs have been made in both units for management purposes. The USFWS has not performed surveys in the Kemwater/McCullough property since 2006. Surveys will not be performed in the area until permission to do so is restored by the land owner. The Domtar unit was also not surveyed this year due to an industrial issue at the gypsum plant on that property.

Figure 1 shows a significant drop in CCW plant counts after 1999. It is believed to be due to increases in invasive plant numbers and composition, wildfire occurrences, possible changes in climatic conditions, soil nutrient makeup, and other factors yet to be determined. However, CCW plant counts began to rise beginning in 2006. More aggressive invasive plant management and the occurrence of only one wildfire between the years 2006-2010 may account for this rise.

It is important to note that the recorded number of non-blooming CCWs is most likely underestimated due to the difficulty in seeing them. The annual grasses and other invasive plants were at peak height at the time of the survey, making wild CCW seedlings very difficult to find. Juvenile plants can easily be mistaken for grasses or other weeds especially for inexperienced volunteers who help with the surveys.

The preferred habitat of the Contra Costa wallflower is natural sand on north-facing slopes. Due to its topography, the Sardis Unit, combined with the PG & E land, contains the most promising habitat for this endangered species. As a result, the Sardis Unit/PG & E has had higher numbers of CCW than the larger Stamm Unit from 1984 until today, with the exception of 1987 (Tables 1,2,3). The percentage of overall CCWs recorded in the Sardis/PG & E units has been increasing since 2005. 72% of the CCWs counted were found on these two units in 2010 compared to 49% in 2005. This may have resulted from the higher visibility of wild seedlings in the more open areas created by recent land clearing (hand and mechanical methods) which promoted seed germination at Sardis unit. Contributing factors that might affect the success of Contra Costa wallflower include one or more of the following: competition with and

coverage by invasive plants, annual or seasonal precipitation, available nutrients, successful pollination, seeding method, and other climatic factors. It is USFWS's goal to restore and revegetate areas to promote the recolonization of native flora at Antioch Dunes NWR, inhibit the domination of invasive plants, and procure a functioning, healthy habitat.

Table 1: Contra Costa Wallflower Totals by Unit 1984-1993.

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Stamm Unit	98	115	99	1,344	299	555	654	431	1,867	1,070
Sardis Unit	720	438	58	112	46	69	218	85	887	1,263
PG&E West	--	28	7	37	22	56	51	35	51	54
PG&E East	--	162	1,298	714	478	1,001	1,100	1,739	4,261	2,505
McCullough	--	44	30	235	101	293	147	270	563	656
Total	818	787	1,492	2,477	974	2,074	2,170	2,560	7,629	5,548

Table 2: Contra Costa Wallflower Totals by Unit 1994-2003.

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Stamm Unit	1,756*	1,548	1,458*	2,867*	2,680*	5,221^	1,210	1,627	589	526
Sardis Unit	6,006*	3,810*	5,281*	5,244*	3,436*	2,979	1,460	2,250	928	963
PG&E West	110*	111*	849*	529*	178*	268	101	147	79	101
PG&E East	2,259	1,962	3,181	1,452	249	2,737	188	527	127	1,397
McCullough	739	363	568	258	104	362	168	433	87	406
Total	10,870	7,794	11,337	10,350	6,647	11,567	3,127	4,984	1,810	3,393

* includes restored areas

^ includes 250 planted in 1998

Table 3: Contra Costa Wallflower Totals by Unit 2004-2010.

YEAR	2004	2005	2006	2007	2008	2009	2010
Stamm Unit	624	741	1,146	1,203	2,060	827	2,453
Sardis Unit	568	502	656	833	1,592	1076	2,483
PG&E West	53	46	43	24	36	7	7
PG&E East	199	326	1,643	1,581	2,805	2,214	3,879
McCullough	86	66	1,093	*	*	*	*
Total	1,530	1,681	4,581	3,641	6,493	4,124	8,822

*Area not surveyed by USFWS; permission not granted by the land owner.

Table 4: Plantings and Seedings in 2010.

Date	#CCW	Unit	MA
1/9/10	40	Stamm	River Plateau Ridge
1/9/10	Seeded	PG&E East	East of Corridor, NE of Tower, Eucalyptus Hill
1/16/10	3	Stamm	Hardpan 3
1/16/10	57	Stamm	Hardpan 4
1/30/10	200	Stamm	Hardpan 3

2/4/10	40	Sardis	South Slope
3/21/10	160	Stamm	River Slope
3/21/10	120	Sardis	Access Road Slope

Figure 1: Contra Costa Wallflower Counts from 1990-2010.

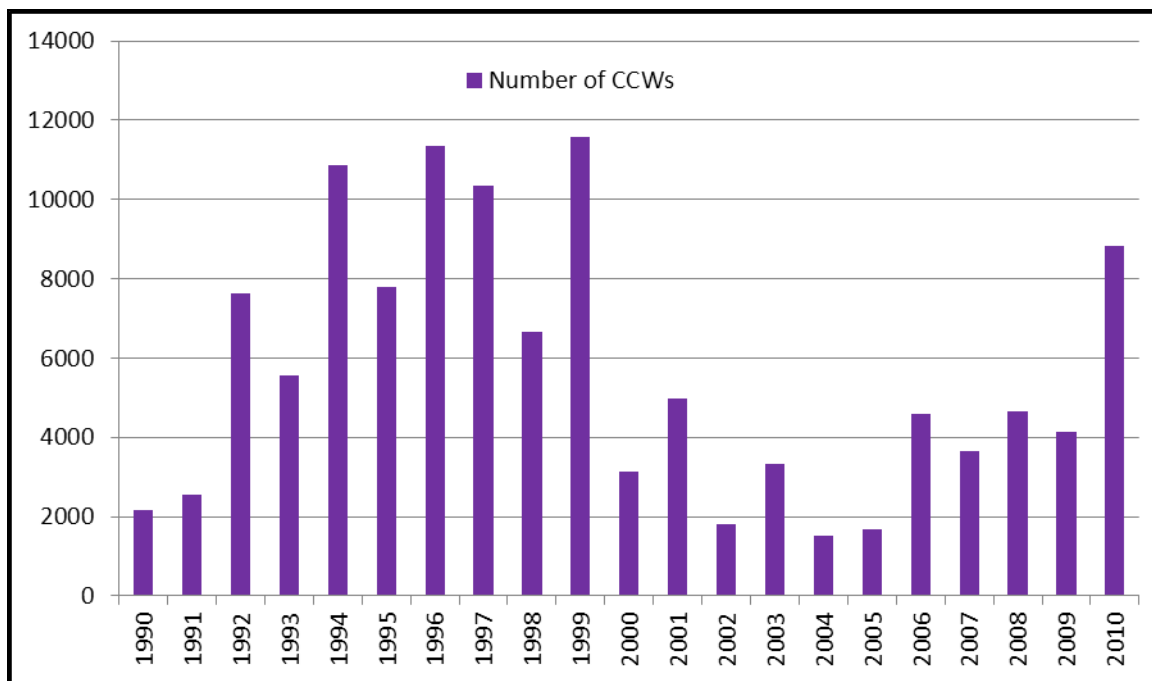


Figure 2: 2010 Contra Costa Wallflower Survey by Unit.

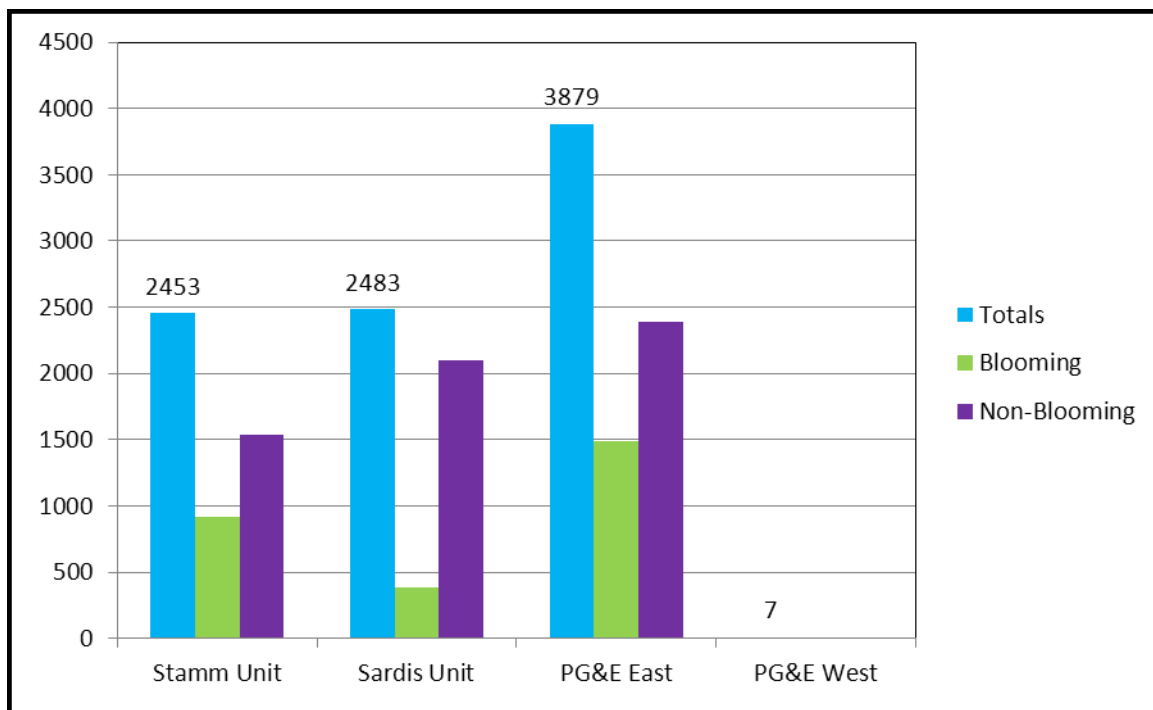
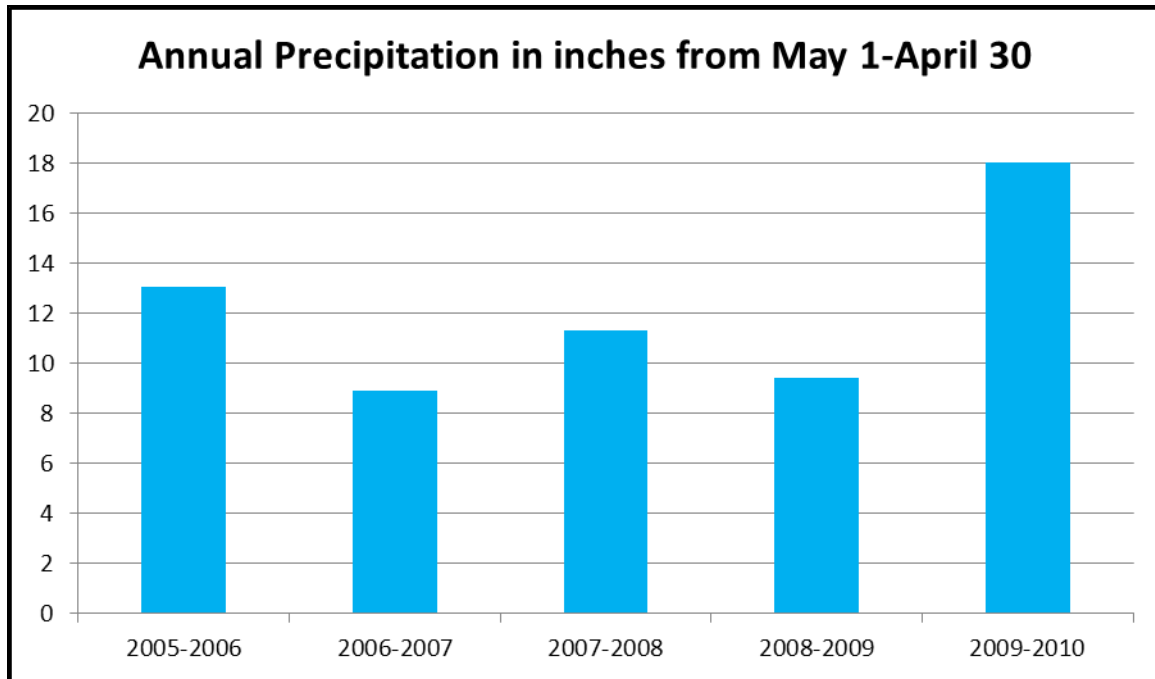


Figure 3: Yearly Precipitation 2005-2010.



**Grazing Management Plan for the Antioch Dunes National Wildlife Refuge
Final Report
2010 Vegetation Management Season**

**Prepared by
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Range Resources 4 Ewe
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Table of Contents

Introduction	3
Site Description.....	3
Grazing Prescription.....	4
Background.....	4
Terminology.....	5
Hypothesis.....	5
Objectives.....	6
Experimental Design and Methods.....	6
Results.....	7
Recent Research.....	11
Summary.....	16

Introduction

The Antioch Dunes National Wildlife Refuge (ADNWR) is a unique inland dune ecosystem host to a number of endemic, rare plants and animals, USDI, Biological Opinion. The management of the ADNWR has consisted of various techniques including mechanical and chemical treatments to eliminate non-native vegetation and enhance several species of status. Species of status include Lange's Metalmark Butterfly, *Apodemia mormo langei*, and its host plant, naked stem buckwheat, *Eriogonum nudum* var. *auriculatum*. In addition there are two endemic federally endangered plant species, the Contra Costa Wallflower, *Erysimum capitatum* var. *angustatum*, and the Antioch Dunes Evening Primrose *Oenothera deltooides* spp. *howellii*.

Site Description

The Antioch Dunes National Wildlife Refuge is located in Contra Costa County, California, Figure 1. It is a unique inland riverine dune ecosystem that is inhabited by number of endemic and rare plants and animals. The site is located approximately 40 miles northeast of San Francisco near the confluence of the Sacramento and San Joaquin rivers, on the south bank of the San Joaquin River. The Refuge is currently divided between two sites, the 44-acre Stamm unit and the 11-acre Sardis Unit, with an additional 14 acres on either side of the Sardis Unit owned by Pacific Gas and Electric.

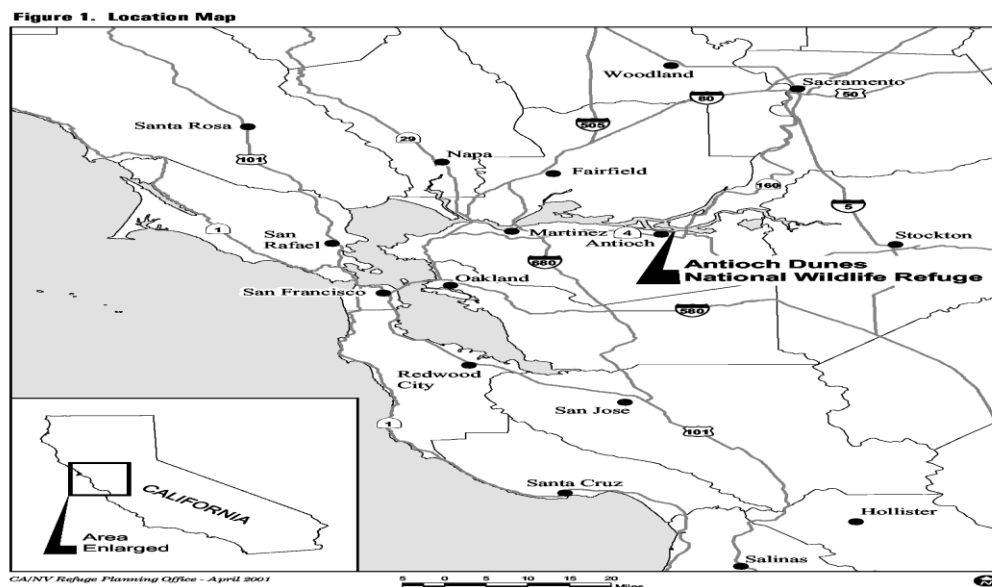


Figure 1. Antioch Dunes National Wildlife Refuge

Background

Lange's Metalmark is known almost exclusively from the Antioch Dunes National Wildlife Refuge in California, which was established largely for the butterfly's protection in 1980. The

butterfly's numbers began to decline early in the century as the growth of San Francisco led to the dunes being mined heavily for sand.

In the early 1900s, the isolated dune habitat in the San Joaquin delta began to experience a dramatic change as human development expanded. Large-scale sand mining and industrial development fragmented the sand dune habitat until only a small portion of the original ecosystem remained. Nonnative grasses and vegetation encroached on the sand dunes to crowd the few remaining endangered plants. By the time the Antioch Dunes Refuge was established, only a few acres of remnant dune habitat supported the last natural populations of the endangered Antioch Dunes evening-primrose, Contra Costa wallflower, and Lange's metalmark.

Ultimately, one of the biggest problems faced by Lange's metalmark is a fundamental change in the dune structure. Formerly a dynamic mosaic of open sand and vegetation, the dunes have slowly been stabilized by the removal of sand and by the introduction of plants which have spread over the sand and now prevent much sand movement. Under these conditions, the butterfly's buckwheat (*Eriogonum* spp.) host plant does not reproduce well. Its seedlings require open sand to become established.

In August 2002, a comprehensive conservation plan summary was released for Antioch Dunes, National Wildlife Refuge. The purpose of the plan was to provide managers with a 15-year strategy for achieving the refuge purposes and contributing toward the mission of the National Wildlife Refuge System. Issues identified by Refuge staff and others, included control of nonnative weeds, identification and development of techniques for successful dune restoration and consultation with experts in dune ecology, restoration and nonnative weeds.

During the past several years, in spite of the efforts of staff and volunteers, minimal disturbance has occurred on the ADNWR site. The vegetation has changed over time and the system is dominated by undesirable species, which are "crowding out" the desired species. The combination of depleted sand, the extensive over-growth of the invasive non-native vegetation and wildfires have seriously degraded the dune habitat, so much that the Lange's metal mark butterfly, as well as the two listed plants, are in serious risk of extinction or extirpation if remedial actions are not implemented.

Management measures have been implanted over the past several years, including chemical, mechanical, and hand pulling as methods for control of nonnative species. These practices, have worked but the invasive of non-natives continues to spread.

Although the Antioch Dunes Preserve is a mixture of annual and perennial species, most of the vegetative biomass is produced by non-native annual grasses whose growth cycles and biomass production vary greatly between years and are heavily influenced by the amount and distortion of precipitation.

Site characteristics determine a range of forage (biomass) production values within which climatic characteristics will determine actual production for a particular year in response to weather. Forage production can vary dramatically between years. Because of this, and the fact that it is virtually impossible to determine the true quantity of forage on a given site, the amount of forage and thus the grazing capacity, can only be estimated and should be used as a guide, with careful observation of resource responses providing feedback for adjustments to grazing intensity and timing. Additionally, because of the high proportion of rip-gut brome, *Bromus diandrus*, common vetch, *Vicia villosa*, and yellow star thistle, *Centaurea solstitialis*, which is avoided at times by grazers, much of the biomass produced may not be utilized as forage unless animals are forced to eat it. Although planning a grazing program involves calculations aimed at estimating a site's forage production, lack of consistency in annual site conditions and other variables required that judgments as to exact turnout date and annual stocking adjustments would be made by the grazing consultant and rancher.

Terminology

One AU is an adult cow (or an adult cow and her calf- referred to as a "cow-calf pair" or simply "a pair") or equivalent. One AU consumes one AUM (animal unit month) of forage per month. Therefore, one AU can graze a pasture that produces 12 AUMs of available forage for one year. One animal unit day (AUD) equals the amount of forage required to sustain an animal unit for one day (about 30 lbs) of forage or about 3% of their body weight. Actual consumption is about 26 pounds per day plus waste.

RDM (Residual Dry Matter) is the amount of herbaceous biomass that should be left at the end of the grazing season to provide suitable conditions for germination of the following year's forage crop and for soil protection. RDM should be subtracted from forage production estimates to estimate available forage. Professional opinions as to appropriate RDM levels vary to some degree and are dependent on land management objectives. An economic objective aimed at producing the maximum amount of high-quality forage might differ from one aimed at providing habitat conditions for a specific species of plant.

Hypothesis

Grazing these sites would reduce the cover of invasive perennial grasses with no impact to the desired perennial forbs.

Objectives

The objectives were to determine if grazing was an effective tool to remove invasive species without causing damage to the targeted protective species, i.e. buckwheat. The three objectives in this research were: (1) reduce invasive species density and cover by 30%, (2) maintain and/ or increase buckwheat density and cover, (3) establish a baseline and normal fluctuation for buckwheat density and cover and relate to the type of weather year.

Experimental Design & Methods

Species

Beef cattle were chosen as the grazing animal because of their preference for grasses. The objectives are based on these preferences, since perennial invasive grasses are highest amount of undesired species to be removed. Cattle have a preference for grasses, which were the target non-native species at Antioch Dunes (e.g. *Bromus* spp., *Hordeum* spp. and common vetch (*vicia* spp.)). Additionally, cattle are locally available and economically feasible. Angus beef cattle would be the preferred breed as they tend to disperse well and move relatively far from water sources, minimizing trampling of sensitive areas.

Timing

Antioch Dunes were grazed during the spring months, March through May. Pastures 1 (West) and Pasture 2 (East) were grazed at a time when non-native annual grasses were approximately 3-4 inches tall and palatable to cattle. Additionally, the moisture content of the annual grasses early in the growing season was high; therefore cattle were not likely to be attracted to species of special status. The exact release date(s) were negotiated by the rancher and the grazing consultant. The removed date(s) were also determined by rancher and grazing consultant, usually based on annual precipitation and forage quantity and quality.

Intensity (Stocking rate)

Grazing intensity (the number of animal units per pasture) was initially different in the two pastures. Pasture 1 had a high intensity grazing regime and Pasture 2 had a light grazing regime. The effect of two different grazing intensities were applied and their impacts measured through the comparative yield (CY) method and Residual Dry Matter (RDM). George et al. (2006) found that the CY method could be used with confidence throughout the year to determine herbage standing crop.

The pastures were grazed by 5-10 cattle each, until the average utilization in the paddock reaches the recommended level of RDM. RDM is the amount of herbaceous biomass that should be left at the end of the grazing season to provide suitable conditions for germination of the following year's forage crop and for soil protection. RDM should be subtracted from forage production estimates to estimate available forage. Professional opinions as to appropriate RDM levels vary to some degree and are dependent on individual landowner's objectives.

Permanent transects were established to measure species competition, comparative yield and final Residual Dry Matter (RDM). The permanent transect aided in establishing the initial baseline data and then determining change in trend of species composition (up or down) as it related to the objectives.

Initial measurements were taken along permanently established transects. Each grazed pasture was measured for species cover and type. The predominant two species were common vetch, *Vicia villosa*, and rip-gut brome, *Bromus diandrus*.

The RDM goal will be a 50% reduction of standing vegetation and an increase of 30% bare ground. The RDM measurements in each pasture will be taken upon cattle removal and in late August. RDM will be estimated using two methods: 1) clip plots and 2) ocular. The use of both methods in conjunction, will provide a good estimation of RDM present (Guenther 1998) without the utilization of systematic clip sampling. The reduction of RDM and the presence of bare ground will be used to evaluate the effectiveness of grazing to remove non-native annual and perennial plants.

Results

Vegetation was monitored, along the transect, to measure the level of removal. The vegetation was monitored by: 1) photo-points, 2) evidence of grazing impacts on buckwheat, and 3) RDM and comparative yield measurements.

Photo-points recorded changes over time in relation to a management regime such as grazing. Photos documentation was taken at the beginning (before cattle were released) and after cattle grazing (at the end of the grazing season).

Grazing impacts on Buckwheat was measured along the established transects. Points from the 100-foot transect, were flagged and individual buckwheat plants measured to determine impact, if any, by grazing. Evidence of biting was the determinant of cattle impact. Certain buckwheat plants were identified prior to the release of cattle. The sites were measure from a 5 meter radius, starting at the southern transect end. The buckwheat was measured at the end of the grazing season, to determine grazing impact. Grazing impact was determined by plant vigor, size reproductive stage and foliage.

RDM and CY measurements were taken along each transect. The RDM goal was a 50% reduction of standing vegetation and an increase of 30% bare ground. The RDM measurements in each pasture were taken in late August. RDM was estimated using two methods: 1) clip plots and 2) ocular. The use of both methods in conjunction provided a good estimation of RDM present (Guenther 1998). The reduction of RDM and the presence of bare ground determined effectiveness of grazing to remove non-native annual and perennial plants.

Grazing Intensities during the first year, there were two grazing intensities used: light and heavy. After the first year, it was determined that the light grazing regime did not meet objectives of removing vegetation in the East Pasture. There was an increase in Yellow Star thistle because too much thatch was left in the pasture. It was determined that the high intensity grazing regime should be applied to both pastures and so they were grazed similarly the remaining two years.

Species composition was measured along the permanent transect before the beginning and the end of the grazing season. The changes in species composition observed over the 3 year experiment are shown in Table 1.

Table 1. Change in Species Composition

WEST Pasture	8/15/08	10/01/10	EAST Pasture	8/15/08	10/01/10
	Ripgut Brome	Filaree		Ripgut Brome Vetch	Bare Ground Filaree
	Ripgut Brome	Bare Ground		Ripgut Brome/ Vetch	Bare Ground
	Filaree	Bare Ground		Vetch	Filaree
	Ripgut Brome	Buck wheat		Vetch	Brome
	Ripgut Brome	Buck Wheat		Vetch	Filaree
	Ripgut Brome	Bare Ground		Ripgut Brome	Filaree
	vetch	Buck wheat		Ripgut Brome	Bare Ground
	vetch	Brome		Ripgut Brome Vetch	Bare Ground Bare Ground
	Filaree	Bare ground		Ripgut Brome	Bare Ground
	Ripgut Brome	Brome		Ripgut Brome Ripgut Brome	Bare Ground Russian Thistle Filaree
	Ripgut Brome	Brome		Ripgut Brome	Bare Ground
	vetch	Telegraph		Vetch	Bare Ground
	Filaree	Ripgut Brome		Vetch	Ripgut Brome
	Filaree	Filaree		Vetch	Filaree
	vetch	Filaree		Vetch	Filaree
	vetch	Ripgut Brome		Vetch	Filaree
	Filaree	Filaree		Vetch	Ripgut Brome
	vetch	Filaree		Ripgut Brome	Ripgut Brome
	Filaree	Telegraph		Ripgut Brome	Bare Ground
	vetch	Telegraph		Ripgut Brome	Ripgut Brome

vetch	Filaree	Vetch	Ripgut Brome
vetch	Filaree	Ripgut Brome	Ripgut Brome
Filaree	Telegraph	Ripgut Brome	Ripgut Brome
vetch	Telegraph	Ripgut Brome	Ripgut Brome
vetch	Bare Ground	Vetch	Ripgut Brome
vetch	Ripgut Brome	Vetch	Ripgut Brome
Ripgut Brome	Ripgut Brome	Dirt	Bare Ground
vetch	Telegraph	Oats	Ripgut Brome
vetch	Filaree	Oat Leaves	Litter
vetch	Bare Ground	Oat Leaves	Litter
vetch	Filaree	Oat Leaves	Litter
vetch	Bare Ground	Ripgut Brome	Bare Ground
vetch	Mustard	Vetch	Bare Ground
vetch	Bare ground	Oats	Ripgut Brome

Table 1 indicated the species changed positively over the 3 year research period. The common vetch was completely removed and the other species changed to a less invasive species that could be continually controlled by grazing.

The changes seen in trend, increase or decrease, of bare ground are shown in Table 2. There was a positive trend (up) in the percent bare ground present. The amount of bare ground increased over the past three years.

Table 2 Change in % Bare Ground 2008-2010

Pasture 1 (East) Light			Δ	TREND	Pasture 2 (West) Heavy			Δ	TREND
	2008	2010				2008	2010		
1	100	70	30	Down		50	10	40	Down
2	60	80	20	Up		70	40	30	Down
3	5	40	35	Up		30	90	60	Up

4	50	60	10	Up		70	50	20	Up
5	60	60	0	-----		20	50	30	Up
6	40	40	0	-----		50	70	20	Up
7	5	20	15	Up		50	60	10	Up
8	0	5	5	Up		50	60	10	Up
9	60	15	45	Down		50	70	20	Up
10	30	30	0	-----		80	60	20	Down
11	20	5	15	Down		70	40	30	Down
12	50	85	35	Up		40	75	35	Up
13	30	80	50	Up		80	70	10	Down
14	20	30	10	Up		30	95	65	Up
15	40	60	20	Up		30	60	30	UP
16	10	100	90	Up		100	50	50	Down
17	20	10	10	Down		70	30	40	Down
18	90	10	80	Down		40	20	20	Down
19	80	30	50	Down		40	80	40	Up
20	40	10	30	Down		40	40	0	-----

Grazing did obtain the desired objective to increase the amount of bare ground. The grazing reduced invasive species density and cover by 30% (Objective 1).

Measurements taken on the buckwheat showed that grazing had no impact to the physiology of the plant. The buckwheat plants were healthy and expressed plant vigor along the permanent transects (Objective 2).

Given the research trial was only conducted three years, a baseline and normal fluctuation for buckwheat density and cover, related to the weather was difficult to assess (Objective 3). The weather patterns were documented and there were minimal changes to patterns (i.e. rainfall) during the three years. Service personnel have indicated that the butterfly populations are still threatened all over the preserve (personal comm.).

Recent Research

The United States Fish and Wildlife Service (Service) periodically reviews and revises listed species information including conducting five-year reviews. These findings, as reported by the Service, overwhelmingly point to the need to sustain grazing regimes and rancher stewardship for the successful conservation and recovery of special status species occurring on California's rangelands.

The following is a summary of recent updates including grazing impacts to listed species occurring on rangelands. Interestingly, in every case where grazing was originally considered a threat it has been found that managed grazing may be beneficial. In addition, for several species, managed livestock grazing has been determined to be essential to prevent further loss

or decline in the species. The five year reviews can be accessed online at <https://ecos.fws.gov/doc>.

San Joaquin kit fox (*Vulpes macrotis mutica*)

In the five-year review for San Joaquin kit fox (USFWS 2010), the Service stated that additional threats to kit fox habitat had been identified. These threats include changes to vegetation structure due to non-native species and altered grazing regimes. Kit fox are vulnerable to coyotes in dense vegetation. Optimal habitat is considered to have low vegetation structure, common patches of bare ground and abundant prey. It has been demonstrated that a reduction or cessation of grazing on sites where precipitation and soil conditions allow the growth of dense vegetation results in conditions unsuitable for kit fox. Grazing by cattle has been identified as the most plausible and economic strategy for landscape-scale management of kit fox habitat (Constable et al. 2009).

Constable, Julie L., B.L. Cypher, S.E. Phillips, P.A. Kelly. 2009. Conservation Of San Joaquin Kit Foxes In Western Merced County, California. Prepared for the US Bureau of Reclamation. May 13, 2009. 48 pp. United States Fish and Wildlife Service. 2010. San Joaquin Kit Fox- 5-year Review: Summary and Evaluation. Sacramento, CA: United States Fish and Wildlife Service. February 16, 2010. 121 pp.

Large-flowered fiddleneck (*Amsinckia grandiflora*)

When Large-flowered fiddleneck was listed, it was thought that grazing may have been responsible, in part, for the extirpation of some populations. In the five-year review, (USFWS 2009) it was recognized that a combination of either the change in the intensity of grazing (possibly a decline in cattle grazing) or the change from cattle grazing to sheep grazing may have extirpated the natural population located at Carnegie Canyon. No plants were seen at this site in 2003.

United States Fish and Wildlife Service. 2009. *Amsinckia grandiflora* (Large-flowered fiddleneck) 5-Year Review: Summary and Evaluation Sacramento, CA: United States Fish and Wildlife Service. January, 2009. 18 pp.

California red-legged Frog (*Rana draytonii*)

Although overgrazing was recognized as a threat to the CA Red-legged Frog; findings since the listing have concluded that managed livestock grazing at low to moderate levels has a neutral or beneficial effect on frog habitat. Managed livestock grazing around ponds can maintain a mix of open water habitat and emergent vegetation. In some cases, without managed grazing, stock ponds would quickly fill with emergent vegetation resulting in habitat loss. In some locations fencing which had excluded livestock from ponds is being removed to improve habitat for red-legged frogs (USFWS 2006). United States Fish and Wildlife Service. 2006. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the California Red-Legged Frog, and Special Rule Exemption Associated With Final Listing for Existing Routine Ranching Activities; Final Rule. April 13, 2006. 71 FR 19244 19346.

California tiger salamander (*Ambystoma californiense*)

Managed livestock grazing by cattle, horse and sheep is thought to be compatible with the successful use of rangelands by the California tiger salamander. It has been recognized that grazing can maintain a low vegetation structure which makes areas more suitable for California ground squirrels whose burrows are essential to California tiger salamanders. The Service (2004) has recognized that the long-term effect of ranching is either neutral or beneficial, as long as burrowing rodents are not completely eradicated. It is likely that CTS would have been extirpated from many areas if stock ponds had not been built and maintained for livestock production. Less vegetation may also facilitate the movement of California tiger salamanders from upland areas to breeding ponds (USFWS 2003). In addition, sustainable grazing around natural ephemeral pools may also benefit the California tiger salamander by extending the inundation period so amphibian larvae can complete their life cycle (USFWS 2004)

U.S. Fish and Wildlife Service. 2003. Endangered and threatened wildlife and plants; Listing of the central California distinct population segment of the California tiger salamander; proposed rule. Federal Register 68:28648

United States Fish and Wildlife Service. 2004. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the California Tiger Salamander; and Special Rule Exemption for Existing Routine Ranching Activities; Final Rule. April 4, 2004. 69 FR 47212 47248.

Palmate-bracted bird's beak (*Cordylanthus palmatus* = *Chloropyron palmatum*)

At the time of listing in 1986, cattle grazing was identified as a major factor in the decline of bird's beak. In the five-year review the Service recognized that cattle grazing may be beneficial, although, it may also have harmful effects. Grazing can enhance habitat for palmate-bracted bird's-beak through the removal of invasive non-native plants. Unmanaged grazing can negatively impact habitat through physical destruction (e.g., soil compaction or wallowing in seasonal ponds. Many areas occupied by palmate-bracted bird's-beak have been grazed by cattle over the years with mixed results. At Springtown Alkali Sink (Livermore, California) an end to intensive cattle grazing in the 1980s allowed the native alkali sacaton (*Sporobolus airoides*), pickleweed (*Salicornia subterminalis*), and iodine bush (*Allenrolfea occidentalis*) to recover. This action also promoted the partial recovery of the palmate-bracted bird's-beak. However, without grazing weed cover increased significantly and palmate-bracted bird's-beak numbers have been declining over time. These results suggest that the short-term results may differ from long-term results of grazing. In its five-year review, the Service (2009) concluded that controlled and properly managed, grazing may be helpful for management of palmate-bracted bird's-beak.

United States Fish and Wildlife Service. 2009. Palmate-bracted bird's-beak (*Cordylanthus palmatus* = *Chloropyron palmatum*) 5-Year Review: Summary and Evaluation. June 2009. 53 pp.

Bay checkerspot butterfly (*Euphydryas editha bayensis*)

Overgrazing has previously been identified as a threat to the butterfly; however, based on current findings, the Service (2009) states that lack of grazing or under grazing is a more common threat. Grazing reduces standing biomass of non-native vegetation which

uncontrolled crowd outs forbs including those essential to the Bay checkerspot butterfly. Since maintaining an appropriate grazing regime is essential to the butterfly's habitat, the Service has also recognized that protecting habitat from development alone is not sufficient. For example, State and County parks are considered "protected" (i.e., not subject to development), but without appropriate grazing regimes, the butterfly has disappeared from historical areas within "protected lands." United States Fish and Wildlife Service. 2009. Bay checkerspot butterfly (*Euphydryas editha bayensis*) 5-Year Review: Summary and Evaluation. August 2009. 42 pp.

Blunt-nose leopard lizard (*Gambelia sila*)

Although overgrazing was previously indicated as a threat to the blunt-nosed leopard lizard, current findings as reported by the Service in its five-year review (2010) suggest that the cessation of grazing is likely to be even more detrimental. Long-term studies of blunt-nosed leopard lizard population trends on the Elkhorn Plain and Pixley NWR have shown dramatic declines in numbers following consecutive wet years and dense vegetation growth. Annual grazing studies in the Lokern area from 1997 to 2005 have demonstrated the benefits of livestock grazing in reducing exotic grasses and increasing blunt-nosed leopard lizard numbers. Decisions to severely restrict or eliminate livestock grazing from conservation lands may negatively affect blunt-nosed leopard lizards. Fire as an alternative vegetation management tool has also been studied in recent years. It was found to be less effective than grazing at controlling annual vegetation because the positive effects lasted less than one year. United States Fish and Wildlife Service. 2010. Blunt-nosed leopard lizard (*Gambelia sila*) 5-Year Review: Summary and Evaluation. February 2010. 78pp.

Calistoga popcorn flower (*Plagiobothrys strictus* Calistoga allocarya or Calistoga Popcorn Flower) and Napa bluegrass (*Poa napensis*)

In the Service's recent five-year review (2010) it was stated that the consistent pattern of heavy growth of nonnative grasses when not controlled by grazing or other management can 'smother' native plants, resulting in the subsequent crowding out, outcompeting, or overshadowing of native annuals. United States Fish and Wildlife Service. 2010. *Plagiobothrys strictus* (*Calistoga allocarya*) and *Poa napensis* (Napa bluegrass) 5-Year Review: Summary and Evaluation. February 2010. 22 pp.

Fresno kangaroo Rat (*Dipodomys nitratooides exilis*)

Although studies in the 1970s identified grazing as a threat to Fresno kangaroo rats, recent studies with giant kangaroo rats (*Dipodomys ingens*) suggest that both overgrazing and complete lack of grazing are detrimental for populations of kangaroo rats (USFWS 2010). Sites which develop thatch from nonnative grasses not only impede the activities of the kangaroo rats and but also competitively exclude the native forbs that are the preferred food source for the kangaroo rats. When grazing was removed by CA Department of Fish and Game from the Alkali Sink Ecological Reserve and the Kerman Ecological population numbers of Fresno kangaroo rats began to decline. Heavy thatch buildup was observed at the Kerman Ecological Reserve as recently as 2008. California Fish and Game is currently working on a contract to begin grazing in the Kerman Ecological Reserve. They are also contracting with California

Department of Forestry and Fire Protection to conduct a prescription burn in the Alkali Sink Ecological Reserve to reduce vegetation cover and thatch buildup and thereby benefit San Joaquin kit fox and Fresno kangaroo rat. United States Fish and Wildlife Service. 2010. Fresno Kangaroo Rat (*Dipodomys nitratooides exilis*) 5-Year Review: Summary and Evaluation. February 2010, 22pp.

Giant kangaroo rat (*Dipodomys ingens*)

Although earlier studies reported the negative effects of overgrazing on habitat quality through competition for food between the cattle and the giant kangaroo rat and the potential collapse of burrows by livestock, more recent long-term grazing studies included in the five-year review have reported declines in the number of kangaroo rats (including the giant kangaroo rat) on ungrazed plots relative to grazed plots during wet years (USFWS 2010). The actual cause of decline in kangaroo rats during wet years is unknown, but a possible factor is dense grass growth, which inhibits foraging; increases the risk of predation by providing cover for hunting animals; and increases soil moisture which may lead to fatal respiratory problems, or the infestation of kangaroo rat seed caches with toxic molds. Livestock grazing can control the dense growth of nonnative grasses that threaten giant kangaroo rats during wet years. The Service (2010) concludes that while overgrazing may disturb individual giant kangaroo rat precincts, the cessation of grazing may lead to a significant decline in giant kangaroo rat numbers particularly during wet years. United States Fish and Wildlife Service. 2010. Giant kangaroo rat (*Dipodomys ingens*) 5-Year Review: Summary and Evaluation. February 2010. 47pp.

San Bruno elfin butterfly (*Callophrys mossii bayensis*) and Mission blue butterfly (*Icaricia icarioides missionensis*). The five-year review (USFWS 2010) recognizes that coastal scrub succession continues unchecked and without a comprehensive grazing and/or controlled burning program, habitat for these two butterflies will continue to slowly decline on San Bruno Mountain. It has been documented that in the absence of grazing and fire, coastal prairie grassland habitats are being lost to shrub and tree encroachment. The recovery plan (USFWS 1987) included livestock grazing as a threat to the survival of the mission blue butterfly due to encouraging the growth of weedy annuals and other exotic plants in the grasslands and reducing the amount of chaparral; however, current studies as reported in the review have shown that managed grazing may increase the density of native plants that support butterfly populations. A stewardship grazing plan was developed for San Bruno Mountain in 2002. Due in part to lack of funding the plan has not been implemented. The Service recognizes that preventing the continued loss of habitat will require sustainable funding sources and/or manpower and/or the reintroduction of San Bruno Elfin Butterfly.

United States Fish and Wildlife Service. 2010. (*Callophrys mossii bayensis*) and **Mission Blue Butterfly (*Icaricia icarioides missionensis*)** 5-Year Review: Summary and Evaluation grazing and/or fire into the system. February 2010. 39pp

Tipton kangaroo rat (*Dipodomys nitratooides nitratooides*)
5-Year Review: Summary and Evaluation

The review (USFWS 2010) recognizes that while there are some monitoring studies underway the biology of the subspecies and keys to effective habitat management essentially remains poorly unknown. Livestock grazing has been identified as a potential habitat management tool to reduce thatch. United States Fish and Wildlife Service. 2010. **Tipton kangaroo rat** (*Dipodomys itratooides nitratooides*) 5-Year Review: Summary and Evaluation. February 2010. 98 pp.

Summary

It is recommended that a grazing program be continued at Antioch Dunes to control invasive species that are and will continue to impact the sand dune habitat. The grazing research documented that cattle grazing can co exist with management objectives of the desired species. The research showed that in the absence of grazing; excessive amounts of residual dry matter remained. This vegetation can negatively impact the survival of the naked stem buckwheat, *Eriogonum nudum* var. *auriculatum*. In addition, other sites on the property that have not previously been grazed should be opened for a grazing treatment to reduce the brush infestation. This infestation could have a negative impact on the host plant, naked stem buckwheat, *Eriogonum nudum* var. *auriculatum*, limiting the ability of this source plant for the Lange's Metalmark Butterfly, *Apodemia mormo langei*.

Working closely with the site biologists, Antioch Dune grazing treatments should be established to reduce any impacts to the naked stem buckwheat, *Eriogonum nudum* var. *auriculatum*, Contra Costa Wallflower, *Erysimum capitatum* var. *angustatum*, and the Antioch Dunes Evening Primrose *Oenothera deltooides* spp. *Howellii*, while providing a quality and quantity source of vegetation for grazing animals.